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The Journal of Genetic Psychology, 1960, **97**, 3-22.

A METHOD FOR EVALUATING CHILD-PARENT INTERACTION UNDER CONTROLLED CONDITIONS*

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A. THE RESEARCH PROBLEM

This article describes a method for studying interpersonal processes, and, in particular, processes of imitation and identification as they may be observed in children at the age 2½ to 3 years, prior to their entering Nursery School. It is believed that "assimilative processes" (a term used for both imitation and identification) may best be detected in the child's natural habitat, the home, preferably in interaction with only one parent at a time. The method is illustrated by a small pilot study.

Child-parent interaction has been considered, especially since the advent of Freudian psychology, as a crucial variable in the child's personality formation. Direct observation as a research tool for studying such interaction has however often been rejected on the following grounds: to obtain a representative segment of the real life situation would require observations over an impracticably long period of time, and over varying locations. Moreover, the manifest, observable behavior would reflect irrelevant factors that tend to cover up relevant underlying processes. These processes could be better revealed by projective techniques. Finally, projective methods, through their standardization, allow for inter-individual comparisons.

Yet, the observational method, in spite of its shortcomings, has been applied by studies in child psychology and has revealed significant aspects of child-parent interaction (5, 11, 3). While in these studies interpersonal behavior was but one among other research aspects, at least one reported study (7) was designed for the purpose of observing and analyzing the interaction of mothers with their small children.

The situational controls in the above studies were held at a minimum so as to elicit the widest range of spontaneous responses. Controlled observation of interpersonal processes, on the other hand, was developed and adapted to children by K. Lewin and his associates (6) and has been applied by one other investigator to interaction within families (10). The latter two studies, however, did not deal with pre-school children.

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* Received in the Editorial Office on December 12, 1958.

The present paper proposes to use controlled situations in the home setting, thus combining the various features of the studies just mentioned, for observing the interaction between parents and small children.

The method is illustrated in application to a particular research problem, that of assimilative processes. Imitation is defined here as the tendency and ability to reproduce what is perceived. Identification is defined, in accordance with psychoanalytic theory, as the absorption into the ego of certain characteristics of another person with whom an emotional tie exists. Although it is realized that the two phenomena may often shade imperceptibily into each other, it is believed possible to establish the relative intensity of the one or the other by using certain operational criteria. (See below, under Assimilative Processes.)

Corresponding to these criteria, a series of tasks was constructed so as to tap (*a*) the child's proclivity for imitative acts in the presence of the model, (*b*) more persistent and behavioral similarity presumably based on identification, (*c*) the child's fantasying of being like the parent, and (*d*) parental attitudes which may influence assimilative processes.

Apart from the wide range of possibly influential spontaneous attitudes of the parent which were hoped to be mobilized, the session was planned so as to elicit patterns of parental control, the parental reaction to the child's failure, and the parental reaction to the child's maturity level as displayed in his performance.

B. METHOD

1. *The Sample*

Four mothers, all living in a new development close to a middle-sized town, were contacted, with the help of a key person well liked in the neighborhood, as to their willingness and that of their husbands' to have a research worker spend two afternoons in their home. The procedures were outlined and readily accepted. The sample was restricted as to age of parents, age of child, and religion. Uniformity of social status was somewhat guaranteed by the fact that they lived in identical types of houses which each family owned and that they had frequent and friendly contact with each other. The only incentive that was mentioned during the preliminary talk was that each couple would, at a later date, be given a sample of their child's voice on a tape. Yet, it was felt that the worker would have been readily accepted without this lure. As one mother put it: "That was a wonderful way to kill an afternoon."

2. *The Controlled Situation*

It had been arranged beforehand that only one of the parents would be in charge at each visit and that the second visit where the other parent would be seen with the child, would take place within the following two weeks. It was indicated that it would be preferred if the not-interviewed parent would not even be present, with the effect that the mother, in all cases, left the house before the interview with the father started. The father was at work while the mother was seen. The research worker brought from her car, readily assisted by the parent, a suitcase with test material, arranged in standard order; two folding tables; a tape recorder; and, in another suitcase, movie camera, floodlights, and electrical accessories.

The parent was asked where she or he usually sits when playing with the child, and the living room sofa was always indicated as that place. The worker set up the sound recorder and stands for the floodlights, with the eager assistance of the parent and then handed the parent the two folding tables (one for him or her, and one for the child), as well as the suitcase with test material, telling the parent that a "guide" (placed on top of the material) would describe the activities and their order. The worker then stepped back and let the parent take over. She had connected the sound recorder and now began taking observational notes. At certain tasks, identical ones in all sessions, she took movie shots.

The reason for selecting this equipment well be explained presently.

3. *Procedure*

a. Writing pads, pencils, and crayons. The parent would copy onto a pad, first a neutral passage, paraphrased from one in Consumers' Reports, and then four abstract patterns. The pad consisted of a board to which were alternately clipped one onion skin sheet and one carbon paper, following an experiment first carried out by Allport and Vernon. On the basis of previous experiments it was hoped that the number of sheets which show any traces of writing or drawing, would serve as a measure of a physiological characteristic which may be called "fine motor pressure." Fine motor pressure in parents could be correlated with that of children in a sample of sufficient size to arrive at similarities on a psycho-motor task. The carbon technique could be more sensitively replaced by newer, e.g., electro-magnetic methods. (The one result which coincided with previous findings was that the pressure as measured by number of sheets was consistently and significantly lower for women than for men.) As with the reading assignment, the writing task was first given in the beginning and again at the end of the session to arrive at the effect of tiredness, tension, etc., generated during the total performance. For this purpose both sets of writing were compared as to pressure, size and neatness of letters and/or figures, time used, etc. The parent handed the child an identical clipboard with paper. (The carbon arrangement introduced, in order to compare fine motor pressure in parent and child, was later abandoned for the child as too cumbersome and as a frequent change of drawing paper seemed desirable.) Next to the writing pad was placed a box with colored pencils. When a sheet was filled or "finished," the worker removed it and clipped on a new sheet from a numbered sequence. The writing-and-drawing task created a situation where child and parent were each occupied with his or her task, yet in close proximity, so that each other's presence may have some influence on their unconscious functions. The evidence accumulated in the present few cases suggests indeed that the child's drawings in the presence of the mother differ from his drawings in the presence of the father. A test of this hypothesis will have to be based specifically on an analysis of choice and variety of colors, and of form, content, and spatial arrangement of the drawings, following methods developed by Altschuler and Hattwick (2) and others. One valuable by-product of the drawing situation was the child's talk while drawing, mostly about the objects drawn. This "fantasy talk" which occurred regularly even in restrained children (though in the latter case after a longer delay) promises to be revealing for unconscious processes, and is of interest for the present problem if comparing the child's talk in the presence of one parent to that in the presence of the other. The sound pick-up needs particular perfection for this part of the session so that no under-the-breath verbalization is lost. The parent's anxiety or indifference with regard to what the child did or said seemed also relevant to the total problem.

b. Puzzle. A wooden puzzle slightly difficult for the age level of this group was chosen. The instruction for the parent read: "Take puzzle out of Envelope 4, for the child."

The differences in parental attitudes varied from volunteering to help immediately, to letting the child struggle unaided; from instructing the child verbally to comforting him through baby talk and caresses and thus "regressing" the child (if it is permitted to use the word in this form). On the child's side the response to a slight frustration, his persistence, skill, and speed of solution were noted as well as the facility of accepting help, and seemed to be connected with the parent's wish for the child's relative dependence or independence as observed in this situation of slight stress.

c. Block building. Two bags with identical sets of building blocks were prepared, for parent and child. The task had two parts. In the first part, the parent was to build a structure, shown on the card of the "guide." Nothing was said to the child who was free to imitate the parent's building or to do his own. In the second part, the parent would again build something, but, this time, say to the child, "Can you build one like mine?" The first part was assumed to tap the tendency to imitate, the second part, to tap the ability or facility to imitate. It may be advisable to set up each part of the task distinctly different from the other and to space their performance so as to minimize the effect of recall.

d. Pat-a-Cake and Peek-a-Boo. The parent had to start each of these games at certain parts of the session. Both games are somewhat babyish for the age group tested. The child's and the parent's ease or reluctance to play the game, seemed to be dependent on the degree of the parent's matter-of-factness vs. playfulness and on whether the parent desired babyishness or achievement and sophistication for the child, as revealed in other ways (see below). The ease of synchronization of movements and the degree of motor inhibition in "pat-a-cake," in the mother-child as compared with the father-child situation, may indicate assimilative processes on a deeper level. The same would seem to hold true for "peek-a-boo" where the facility of tolerating the broken contact with the parent may correspond to the strength of identification with the parent as suggested by behavior in other parts of the session.

e. Doll play. A baby doll was handed to the child and the child was asked to "give dollie a drink"; "blow dollie's nose"; "make dollie sit down." The doll elicited two types of response which could be compared: by the child handling the doll and by the parent responding to both the doll and the mothering child. The doll was also assumed to reveal differences in sex typing as boys in the age group studied would, on the average, be less responsive to a baby doll than girls. Again, one may study the relation between the parent's reaction to the doll and to the child's doll playing and the boy's or girl's behavior towards the doll. It should be remarked that a structured doll play situation, with the interviewer in charge, might also be revealing for the processes under investigation. [See W. Emmerich's study (4) where identification responses were elicited through doll play.]

f. Naming objects, repeating words. These two tasks were intended to tap the child's own speech pattern as well as his tendency to reproduce that of the parent. In the first test the parent showed cards with simple pencil drawings of a shoe, dog, cup, leaf, fish, cake, etc., all together 14 drawings, asking every time "What's that?" The words were chosen, with the help of a linguist, so as to cover all English vowels present at the 2½ year level. In the second test the parent told the child: "Say—shoe, dog, cup, leaf, fish, etc." and waited for the child to repeat the word. A comparison of the child's speech patterns (especially in intonation, pitch, "adultness" of speech) on both tasks, shows the shifting from the child's own way of talking in the direction of that of the parent. This shift could be quantified to some degree, in the second test, by locating the rank order of the word(s) at which the shift is completed.

g. Nursery rhyme. The parent was requested to read to the child, "Twinkle twinkle little star," from a Mother Goose book. Here one could observe whether reading to the child was a familiar happening; whether parent and child, at that occasion, were physically close; what was the emotional quality of the parent's voice (a genuine poetic vs. a pedantic or monotonous reading of the rhyme); and what was the child's response to either parental pattern. Did he repeat the words after the parent in a drill-like fashion, or did he enjoy pronouncing them together with the parent.

h. Movie shots.

(1). *Performance on tasks.* Of the tasks performed the following were photographed with a 16 mm. movie camera: Puzzle, block building, doll play. Certain details of performance in the puzzle and block building were believed to emerge only upon repeatedly inspecting the film, in particular with regard to the parent's participation in the tasks. The child's fine movements and the sequence of handling the doll seemed worth a more detailed inspection than is accomplished by mere observation. Some of the other tasks too may reveal unexpected incidents, overlooked during the session. Yet, on the basis of this pilot experiment, it would seem important not to surrender to the camera too much of the Gestalt of an incident seen by the eye while it happens. It also seems likely that too much attention on the camera may impede the observer's acuity and sensitivity of perception.

(2). *Walking.* The parent and child, in turn, were photographed while walking forward and backward without shoes. The purpose was to trace similarities in gait, as a psycho-motor act. Slow motion exposure, which has not been tried, may be useful.

C. Treatment of Data

The data collected by the home visit method are of the following types: sound recordings of interviews and of parent-child sessions; observational record of the tester; movie shots of parent-child situations; free drawings of the child. So far the data were analyzed mainly in qualitative fashion. Such data should be analyzed, in addition, by using scales adapted to the evaluation of those personality characteristics on which the particular study centers. Some of the rating scales developed for parental behavior in previously mentioned related studies of non-controlled situations (e.g., 1 and 4) can be applied also to controlled observations described here. The degree of imitation and identification in the child (on which the present study was focussed) would require especially constructed rating scales. The size of the sample did, of course, not permit of the use of statistical methods. In fact, it is perhaps less fruitful to increase the size of the sample than to study each single case with greater intensity.

D. Two Examples Illustrating the Method

The method described here will be illustrated by presenting excerpts from transcribed recordings of visits to two homes, that of Stephen, 3 years old, and that of John, 2¾ years old. Stephen is the only child, John has a 6-month-old brother. The mothers are 28 and 25, the fathers are 35 and 32 years old. Stephen's father is a teacher and John's father a white collar worker (office employee). It is realized that there are situational differences between both cases which may influence some of their behavior. To facilitate the presentation the following symbols will be used:

Stephen's father —— F_s
Stephen's mother —— M_s
John's father ——— F_j
John's mother ——— M_j
Stephen ————— St
John —————— J

Those words which could not be clearly understood upon listening are designated by a broken line (———). The typewritten transcripts used for the present illustration constitute only one type of all the data. They would gain considerably in conclusiveness if supplemented by tone of diction and by movie photographs.

1. *Parental Control*

The first assignment on the "guide" (writing and drawing) elicits the first verbal reactions to the test situation and provides some indication of the parent's handling of the child.

> *a. Stephen with father.* F_s: Come on, sit down, Stephen. We've things to do. Now sit down here, Stevie, all right. Stephen, come over here and sit down, Stephen. Sit down. "Take envelope, marked 2. Take pad and pencil." Oh boy, now we've something to do. . .
> Draw something, Stevie. Here, draw something. Draw something.

b. Stephen with mother. M_s: I'm going to give you that and I take that, and I think there are some pencils in here for you. Colored pencils, is that right? (to observer) We have to use colored pencils. Oh, look at that. Which one would you like to take? All right. Okay. Well, you draw something. Something you like to draw.

c. John with father. F_j: All right, we're doing the first one, right? Are we ready? J: I want the box. Can I have the box? F_j: I am writing, sweetheart. Well, let me finish this. J: May I have mine — — — ? F_j: Yes, sweetheart. Now you draw something, sweetheart.

d. John with mother. M_j: Johnny, come over here. You know I'm going to open something. Come on over here. J: What is it? May I — — — ? Mj: No, come over here. I'm going to do this, and then we're going to take something else out. (To observer:) You want me to start? J: Look, Mummy. Mummy, look. M_j: Look what we have here. J: What? M_j: Look at that. D'you think you can draw something? What would you like to draw?

e. Interpretation. The instructions read: "Give one pad and pencils to the child. Tell the child to 'draw something'." How does each parent convey the instructions to the child? There is more direct, verbalized attempt at control in Stephen's than in John's case. F_s tells St to sit down four times. M_s puts herself in charge of the situation from the beginning: "I'm going to give you this — — — and I take that." Even in this first passage there is slightly more tension or "nervousness" noticeable in F_s than in M_s and more self-assertiveness in the latter than in the former.

The contact of John's parents with John is casual (often interrupted by John), and friendly. F_j is explicitly affective ("Yes, sweetheart. Now you draw something, sweetheart."). The repetitive use of "sweetheart" may conceal some apprehension. M_j (similar to M_s) seems more at ease, as will be seen later, than F_j. The differences in parent-child relationship become clearer during the actual writing task:

Neither M_j nor F_j address J who is drawing while they are writing. They do not ask him any questions about the things he draws though he provides ample information on his drawings, and during his "fantasy talk," especially in the presence of the father. The following communication takes place in Stephen's case:

f. Stephen with father. St: See that's an S. That's a moon. F_s: What' d'you drawing, Stephen? There's more paper under here, Stevie. St: I want those colored crayons. F_s: You will. St: Can I have more crayons? I'll have these. Oh. F_s: Oh, what? Take it easy. Take it easy. Can you make a drawing for Daddy and Mummy too? St: No.

g. Stephen with mother. St: Look what I make. M_s: Oh, isn't that

> interesting. St: Can I only use one (crayon)? M_s: No, you can use them all. Here is another if you like. I keep that. (while writing) What're you making, Steven? St: Look at that. M_s: What's that? St: paintbrushes. M_s: Yes, paintbrushes. (to observer:) He's just enjoying using one color after the other. St: Here, Mummy. Here, Mummy (louder, higher). Here Mummy. M_s: I can't do without——— Not as quick——— Whoopsedaisy, now be careful. What else will you make? St: I want something different this time. M_s: Okay.
>
> St: (to observer:) See what I'm making? You like it? See? M_s: Don't you want to make a girl? With all these colors? St: Look. M_s: What is it? St: A circle. M_s: Oh, a circle. St: Look at this, all this is green. M_s: A nice design. St: Orange and green. M_s: Be careful. St: A moon, see that? M_s: Yes, I see. St: Look what I did. I'm writing something. M_s: Oh, dear you're bearing down too hard, that's the reason for that. St: (to observer:) See what I'm doing. M_s: Show Mrs. M. one of those nice girls you can make. You can do that, especially with those colors. St: (tears off a page). M_s: Listen, you don't need a new page. You have lots of room to make a girl. Care——— All right, go ahead. St: Give me another piece. M_s: Can't you do something that looks like a good job? You know, (to observer:), that's what I tell him. You know sometimes when he does something I know he's just doing it haphazardly. He'd say to me: "You think the teacher will be angry with me?" I'd say, "Oh, she does like boys and girls to do careful work, you know." Sometimes it's just the sheer joy of doing it. . .

h. Interpretation. While John's parents are unconcerned with John's drawing, Stephen's parents are conscious of whatever activity Stephen is engaged in. M_s more than F_s never really seems to want to lose hold of Stephen. Both Stephen's parents do some "curbing" of movements (F_s: "Take it easy; M_s: "Now be careful. Be careful.") and of initiative (F_s: "Can you make a drawing for Daddy and Mummy?" M_s: "Show Mrs. M. one of those nice girls you can make."). The not concerned, not interfering attitude of John's parents seems to facilitate John's exploration in drawing and fantasy talk (e.g., in session with father: "I make a moon. This is red. Is this red? I'm in the office. There are the guns. It's raining out. Look, it's raining out, Daddy. Now I'm making a boat. Look at all the rain. There are rain drops. Make a boat. Make a big boat. Look at all that rain. There's the anchor right down there. Little, little. That's a boat. Make water. Rocket. See, when they go up in the air then they come down into the water, then they soak . . ."). Stephen reacts to his parents' manipulativeness by giving in and keeping in continuous verbal contact with them. He seems more "interlocked" with M_s than with F_s. When F_s suggests for him to draw a certain picture he rejects it. When M_s makes a similar suggestion he disregards it at first but follows it later (St: "Now, I'm making a girl."). Only in certain outbursts of loudness during the session with M_s does St reveal some aggression. M_s's control over St is more effective, she manipulates St with more insight and with less noticeable involvement than F_s as will be seen later. It seems that both M_j and M_s, though both apply divergent methods, are perceived by their children as more dependable and supportable than F_j and F_s.

2. *Parental Reactions to the Child's Failure*

These are elicited mainly by doll play and picture naming. Test items not successfully passed by the child may constitute a threat to the parent for varying reasons, e.g., because the child is exposed to a painful experience or because the prestige of the child and thus of the parent is endangered. Correspondingly, the parent's method of overcoming the threat may take the form of over-affectionateness or irritation. The child's passing an item in the presence of one parent and failing it in the presence of the other, would seem to depend partly on the child's relationship to the parent.

a. John with mother. M_j: Oh look at this. Stand right here and look while I take this out. I wonder what's in here? J: pineapple. M_j: Pineapple? 'Cause it looks like a bag for grapefruit. Oh —— what is —— this? What're these? J: Eyes. M_j: And what's this? J: Mouth. M_j: And what's that? J: Nose. M_j: And can you give dollie a drink? ——— Can you blow the dollie's nose? J: No. M_j: Can you make dollie sit down? J: No. M_j: D'you want to give dollie a drink? And blow dollie's nose? J: No. M_j: D'you want to make the dollie sit down? J: No. M_j: Maybe dollie'd like to sit down on the table. See whether you can sit her down on the table. J: She wants some milk.

b. John with father. F_j: All right, sweetie. Oh boy, we're going to take the doll out. You stand over here, next to Daddy. Daddy's going to take the instruction card out. Now I'm going to point to the different parts of the dollie and you tell me what they are, all right? What is this J: Eyelash. F_j: What part of the dollie is it? That's the dollie's what, sweetheart? The dollie's what? J: Eyelashes. F_j: Eyelashes, all right. And what's this? What's underneath the eyelashes? The dollie's (no answer) And what's this I'm pointing to? The dollie's? —: Nose. F_j: And what's this? The dollie's what, sweetheart? Mouth, o.k. Now give the dollie a drink. Now make the dollie sit down. That's the boy ———. We'll put this down, all right and we come back to it later.

c. Stephen with mother. M_s: Oh, listen, I have a doll. St: A doll? M_s: Will you go where you're supposed to sit, please? St: What's this in here, Mummy? M_s: It's a doll. St: A doll? M_s: Hm. St: ——— M_s: Well, we'll see. Oh, isn't that nice? St: What has she on, Mummy? M_s: She's got shorts on, I guess. I want to ask you something. Tell me what these are? Right here, I'm pointing to? St: Eyelash. M_s: No, but

> underneath that? What does she see with? St: Eyelashes. M_s: I know but what's underneath the eyelashes? You see it? St: Yeah. M_s: What is it? Something you have too. What is it? Hm? What is that? St: (whiny) I don't know. M_s: You don't know what they are? Then you tell me this: What's this? St: Nose. M_s: All right and what's this? St: Mouth. M_s: Is her mouth open or closed? St: Open. M_s: Show me dollie's eyes then. All right why didn't you tell me this before? You told me they were eyelashes, huh? Show me her nose (slightly irritated) And her mouth? St: Here. M_s: All right. Now will you give dollie a drink? How'd you give her a drink if you'd to do it? Oh, look at that. What'd she got there? St: A bottle. M_s: A bottle. St: Where's the water? M_s: Where's the water? We're just pretending. All right, this you ought to know ——— St: (taking the doll's clothes off) She doesn't have a cold. M_s: She doesn't have a cold? Well, then make dollie sit down if she doesn't have a cold. Make her sit down, sweetheart.
>
> *d. Stephen with father.* F_s: You know what's in here? St: A doll? F_s: A doll, yeah. Let's see, what's this? St: I don't know. F_s: Yes, you do know. Come on what is it? St: —— don't know. F_s: Oh yes, you do know. Come on, what is it? St: don't know. F_s: Yes, you do know. Come on, what is it? Mrs. M. wants to know what it is. St: (under his breath) You don't like me. F_s: I haven't said — — come on what is it? St: Eyelash. Fs: No eyelash. What's under the eyelash? St: This ——— F_s: No, what do you see with? St: Eyes. F_s: Of course. And what's this? St: Nose. F_s: Of course. What's this? St: ——— F_s: Give the dollie to drink. Come back. That's the way we have to do it. Give the dollie to drink. Now blow the dollie's nose. (Telephone rings) St: I'll get it. I'll get it.

e. Interpretation. Most of the "make dollie. . ." items are failed by John in the presence of M_j. "Show me dollie's eyes," is not passed in the presence of F_j though it was passed previously in the session with M_j. John's "No's" to his mother do not seem to express conflict with her. They rather seem to arise from resentment against the unusual situation in which the mother, in a somewhat impersonal fashion, asks questions of him and, in particular, asks him to treat the doll as he may wish to be treated by the mother. John's refusal would then signify libidinal frustration. This interpretation seems consistent with John's performing well on the same tasks in the father's presence with whom the libidinal ties may be less strong (see p. 17).

Neither M_j nor F_j respond to John's failure with irritation. M_j's voice remains unimposing and warm as before. She tries to help J by rephrasing the tasks in a more appealing manner. M_j must to some degree be frustrated by J's non-compliance. Yet the frustration does not reach her relationship with J. F_j shows more anxiety about J's failure or potential failure, than does M_j. Yet, as in M_j's case F_j's affectionate tone and feeling towards J

does not change. F_j's way of warding off such anxiety consists in showering endearing names on J and babying him more than usual. This is illustrated by the following quotations from the picture naming task:
(The naming of the pictures by the child is left out.)

> F_j: Now I'm going to take these cards out, sweetheart, and I'm going to ask you what they are, sweetie, and you tell me, all right? No, sit over here with Daddy, all right? Over here, back of the table. Come on over here, sweetie, please. Now what's that, sweetheart? J: Dog. F_j: That's a dog, okay. What is this, darling? ——— That's a shoe all right. Now what's this, sweetheart? A cup, okay. And what's this? What's this darling? —— What is that? Oh boy! And what is this sweetheart? And what is this darling? And what is this sweetie? etc.

Both F_j's and M_j's responses to J's failure differ from F_s and M_s when faced with St's failure, insofar as the latter experience the incident as so painful that the friendly contact with the child is broken, at least momentarily, and hostility comes to the fore: (M_s: "All right why didn't you tell me this before?" F_s: "Oh yes, you do know. Come on, what is it?") (The parents' aggression is still more noticeable when listening to their voices than when reading their words.) M_s remains calmer and recovers her former feeling tone towards St more easily than does F_s. M_s is more self-assured and, in her way, more supportive than F_s. Thus counteraggression develops against F_s but not against M_s. St's aggression does hardly recede during the rest of the session with F_s, as illustrated in the following quotation:

> Nursery Rhyme: F_s: Twinkle, twinkle little star, d'you want to say the whole poem, Stevie? Twinkle, twinkle little star. St: Oh, no-no-o. F_s: We'll have to. Mrs. M. will have you do it. Say twinkle twinkle little star. St: Oh, don't skip it (instead of: skip it). F_s: Oh, skip it, nothing (nervous laugh). Come back here, now come on. St: don't skip it. F_s: Stevie, we have to. St: Don't skip it. F_s: Stephen, Stevie. St: Don't skip it. Get away from me. F_s: Come over (laugh) here. St: No, I won't. etc.

Whenever F_s realizes how inadequate his control over St has become, he appeals to some other authority, to M_s or, as here, to the observer.

3. *Parental Gratification Through the Child's Performance*

As has been pointed out M_j and F_j do not attempt to make John excell beyond his required performance. They do not suffer a personal injury upon failure. M_s and F_s, on the contrary, convert, each independently, parts of the session into a "learning experience" (a word used with much approval in one of the interviews). To give some examples, M_s, after the block building task, told J, on her own account:

> All right, now I tell you, would you pick out the ones for me, Stevie, which have this color crayon? St: Yes: M_s: Thank you, thank you — this color — that's right — good. Now let's see whether you can put all these in the long envelope. Can you put them in the long envelope?

The suggestion made by M_s to St to draw a girl belongs here too. There is little doubt that the correct execution of the ad hoc assignments, in the presence of the observer whose judgement is respected, gratifies M_s or, in psychoanalytic terms, brings her narcissistic gain. F_s seeks similar gratification during the picture naming part:

> F_s: And this? St: A leaf. F_s: I wonder what kind of leaf that is? (a self-initiated question.) You know what kind of leaf? St: A oakleaf? F_s: — — — what kind of bird? St: A coo — a coo. F_s: Doesn't it look like a blue bird?

It may be significant that each of the parents chooses that area for the child to excel in for which each has a personal preference. M_s likes to paint and F_s would have liked to study biology. Again, M_s's requests are more geared to St's capacity, while F_s's demand overtaxes St's knowledge by asking him to identify a bluebird from a rough pencil sketch. St tries to oblige in both situations, to either parent. He has come to know and strive for the pleasure that his parents bestow on him when he satisfies their requests to excel. His repetition of the words pronounced by the father follows immediately, with even less delay than when pronounced by the mother, and in a parrot-like fashion.

In the case of M_j and F_j, there is much more delay, interruption by questions, and playful loitering before the words are repeated, and, in the session with M_j, there are straight refusals to repeat the words. Correspondingly, on the parents' side, F_j and M_j's need for narcissistic gratification through their son's performance seem to be minimal, if compared with that of M_s and F_s, as was shown in their lack of hostility at J's failure.

4. *Assimilative Processes: Imitation and Identification*

The following criteria were applied to discriminate between imitation and identification: Identification is more persistent; in the case of imitation, the similarity with the model, achieved during an imitative act, does not necessarily persist. Identification depends on an affective relationship with the model; imitation does not require such affective bond. The imitative act is always performed in the presence of the model; identification may occur in the absence of the model. Identification is accompanied by the identifier's fantasy that he is like his concept of the model; such a fantasy is not characteristic of imitation.

By the above criteria, three aspects of imitation could be tapped through the tests: Fine motor imitation, in the building block task; verbal imitation in Repeating Words; synchronization of movements in Peek-a-Boo, of speech in Nursery Rhyme, and of movements and speech in Pat-a-cake. It is realized that these tests do not constitute "pure" measures of imitation if given by the parent. In any future research on the subject, a third person, the tester, will administer these tests, in addition to the parents, and differences in the child's performance in both situations will be analyzed.

Identification would be operating if the child consistently reproduces the parent's motoric or speech pattern; if in the child's fantasy talk one parent's interests, values, prohibitions, and other characteristics appear; if the choice of the child's defensive attitudes, under stress, resembles that of the parent's defenses; if the sex-typical behavior and degree of adultness displayed by the child coincides with parental preferences in these areas, whether verbalized or otherwise demonstrated in the contact with the child. In all these cases of child-parent assimilation the assumption of identification with one parent would be strengthened if the emotional attachment to this parent appears to be stronger than to the other parent and if behavioral similarities with the former could be observed in his (her) absence, i.e., during the session with the other parent. One type of quantitative assessment of the parent's appraisal of the child's maturity may be derived from the sound recordings by computing the relative frequencies of the parent's *terms of reference,* i.e., words used when talking about oneself to the child (e.g., "Daddy" or "I"), and *terms of address,*[1] i.e., words used when directing one's talk to the child (e.g., "Sweetie" or "you").

John

a. Imitation. The following pattern of imitation could be elicited: In the session with M_j, fine motor imitation was failed [M_j: "I bet you can't build one like *this.*" J: "No. I can build one like *that.*" (playful, high pitch on "that" similar to M_j's "this").] Verbal imitation also failed. Synchronization of movements in peek-a-boo appeared after some coaxing. There was distinct synchronization of movement and speech in the pat-a-cake game:

> M_j: Pat —— M_j and J together: a-cake, pat-a-cake M_j: baker's man. M_j and J together: cake as fast as you can. M_j: You pat it and then

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[1] The two terms (of reference and of address) are derived from A. R. Radcliffe-Brown's anthropological analysis of behavior patterns within families and clans. As in anthropological studies, the relative frequency of certain types of the parent's and of the child's terms of reference and of address were believed to indicate actual inter-personal processes on a deeper level.

what d'you do after you pat it? You roll it and mark it with J: J. M_j: and put it in the oven for —— J: me and Georgie (brother).

In the session with F_j, fine motor imitation is partly achieved, with considerable help of F_j. Verbal imitation was achieved by means of affective prodding as related earlier. Peek-a-boo was performed in a similar manner as with M_j. (Pat-a-cake does not appear in the recording and may have been left out.)

b. Identification. Reproduction of M_j's speech pattern occurred several times in the session with F_j where a phrase of M_j was reproduced with M_j's high-pitched surprised intonation ("Oh, what d'we have in *there*?"). The objects drawn by J or thought about during his fantasy talk, are mechanical things, and in addition, in F_j's presence, parts of nature (rain, water, rain drops). There is identification with F_j when he says that he is "sitting in the office." The mechanical themes would point to identification with one aspect of F_j's ego ideal, his fascination by machines evident from statements by both M_j and F_j, and in F_j's enthusiasm about the sound recorder and camera. Both M_j and F_j said in their interviews that J resembles F_j in being mechanically minded.

There is more naming of colors in the presence of M_j and there are many more colors used in the session with her. The greater freedom in the use of colors and of total space, in drawings done in the session with M_j as compared with those done in the session with F_j, may point to J's identification with M_j of an earlier more primitive kind which would be consistent with the ease with which J reproduced M_j's tone of voice even in her absence.

It is worth noting here that the actual mechanical tasks where both imitation and problem solving play a role (block building, puzzle) are failed by J. This failure may be a function of the gap between his ego ideal, a mechanical know-it-all, and a realistic task at hand, or it may be due to his being somewhat restricted from developing intellectually.

As to parental defensive attitudes recurring in J his negativism in the session with M_j is somewhat paralleled by M_j's initial reserve towards the observer which never quite disappeared. Both M_j and F_j remark on J's shifting from one activity to the next one too easily, an attitude which may have evolved in the lenient atmosphere around him, but against which he himself reacted with attempts at perserveration as seen in the session with M_j. For this last example of a defensive attitude there is no indication of a similar tendency in one of the parents. It may well be that not the similarity of defensive behavior but the intensity of any such behavior mobilized in contact with a parent may express the stage of identification with that parent.

With respect to J's identification with the parents' sex-typing, neither M_j

nor F_j accentuate J's maleness in talking or behaving to him, nor in the way he is dressed. The doll play would typically arouse more excitement from a girl than from a boy. Yet J was fascinated by the doll which was the only toy except for the colored pencils which caused some perserveration, i.e., he interrupted other activities to play again with them or asked for them repeatedly.

c. Terms of reference. F_j's terms of reference consist of We (what d'we have in here?), Daddy (Daddy's left you some room here), and I.

d. Terms of address. F_j's terms of address consist of sweetheart, sweetie, darling, Johnny, you. The name John is used neither by F_j nor by M_j. M_j refers to herself always as I (not as Mummy) and addresses John as Johnny and you, and only twice during the whole session does she apply a pet name to him. M_j treats John in other respects too, as the small boy which he is, not as a baby. Yet John's level of maturity in behaving and talking would in certain ways, correspond more to F_j's appraisal of him as a baby (F_j said in the interview: "He is almost a baby. He's not much more."), than to M_j's appraisal of him, as adequate for his age. M_j said in the interview that J was always more on his own and different from his baby brother who wants the mother around all the time. On a deeper level, M_j, too, may desire J's dependency on her. His whiny way of talking, his infantilism in speech (ssire instead of fire), his still having a bottle, all this may express his identification with F_j's verbalized and M_j's unconscious approval of his immaturity.

Stephen

a. Imitation. Fine motor imitation was easily elicited and was successful, in the presence of M_s. The structure copied from M_s's design reappeared, 10 days later, in the session with F_s, even before F_s had started on his structure. It will have to be decided whether such feats of imitation and memory will be attributed to imitation or to identification, in the present case, with M_s. Verbal imitation was executed without error or delay, both with M_s and F_s present. The notes taken while listening to the recorded session with F_s read: "F_s's staccato, drill-like enunciation followed almost immediately by St's repetition, in similar tone." There was hardly any synchronization of speech in the pat-a-cake game neither with M_s nor with F_s present.

b. Identification. M_s's speech pattern during the running conversation, was reproduced by St in the following manner: A few times words that M_s had mentioned while reading the passage or while talking to the observer were "mirrored" by St in a faint voice, e.g. "Where's that model?" after "model" had been said. Mutual "mirroring" also occurred between M_s and St: M_s: "Oh, listen, I have a doll. St: a doll. M_s: I'm going to give you some blocks. St: some blocks. St: I'll do it all over again. M_s: all over again. St: She doesn't have a cold. M_s: She doesn't have a cold." This "mirroring" does not occur in the session with F_s. It may be considered as a mannerism characteristic of the interaction of M_s with St and of their emotional tie. St may identify with M_s by mirroring speech sounds coming from her.

Piaget, in *Language and Thought of the Child,* has described the child's repetition of words picked up at random (echolalia), as a confusion between the I and the not-I: "The child mimics with his whole being identifying himself with the model." Yet, the possibility of a selective choice of the model for mirroring based on identification, in the psychoanalytic sense, is not discussed.

As in J's case, the fantasy talk contains more naming of colors in the mother's than in the father's presence. Yet, compared with J's fantasy talk, St's verbalization during the drawing period is more restricted, except for the beginning of the period in the session with M_s. Here St seems almost unable to cope with the excitation of the stimulus of empty paper and colored pencils. His "Here, Mummy. Here, Mummeey," repeated several times in high pitch seem to reach out for M_s's support and control in handling his excitement. M_s's continuous interfering with St's drawing, is only one indication of the ever present protective and restrictive influences coming from both M_s and F_s. St's inhibited drawing and choice of colors and the scarcity of the themes he talks about ("circle," "straight line", "round", "two railroads") may be his identification response to both M_s and F_s's pattern of control.

With regard to St's defensive attitudes resembling parental defenses, his negativism followed by verbal aggression in the presence of F_s is matched by a certain sarcasm in Fs and a fastidious attitude to some of the tasks, and by counter-aggression towards St.

As has been pointed out M_s also showed hostility when St in spite of all her prodding failed to produce the "right" answer.

There seems to be some incongruity in St's sex-typing by his parents. He is visualized by F_s as a college student taking up the field of his own (F_s's) choice that had been barred to him. St has been taught to memorize his future university. M_s too has fantasies of St excelling in a scientific career which she herself would have chosen. On the other hand St has been made to feel guilty at any independent action. Both M_s and F_s, in their interviews, point out similarities between M_s and St, with respect to motor skill, artistic ability, preference for reading (!). M_s suggests to St to draw a girl to which St gives in, after initial resistance. It is possible that M_s, through her subconscious masculine strivings (expressed in other ways, e.g., she is the planner and decision maker) identifies so closely with St and fosters his identification with her.

c. Terms of reference. M_s and F_s never refer to themselves as "Mummy" or "Daddy", but always as "I".

d. Terms of address. Pet names are used in addressing St twice by M_s and not once by F_s (M_j calls J by Pet names 3 times and F_j 24 times). The full name Stephen (instead of Stevie) is used about ¼ of the times by M_s and F_s whereas John is never addressed by his full name. St addresses M_s 6 times. He does not address F_s once. (M_j is addressed by J 10 times, F_j once).

The names of reference and the names of address used in St's case point to an appraisal of St as a more mature person than John as he is appraised by his parents. This verbal usage is paralled by other expressions of behavior. F_s even surpasses M_s by treating St on equal footing. The movie shots show F_s sitting distinctly apart from St and the observational record notes that F_s sat erect, for a long time, hardly turning his head while St was trying hard to solve the puzzle. F_s's attitude during the interview is described as follows: "F_s has a detached way when talking about the boy: 'He has a good temperament', 'He is a good boy', as if talking about someone not that close." Thus, with regard to St's maturity level, both parents appraise him as advanced for his age. St identifies with such appraisal by prematurely developing mental abilities, such as verbal memory, and by his facial expression. The report describes him as follows: "Pale face, tired eyes. Lack of child-like features, except for a soft, surprising smile, occasionally. Adequate body build." Yet, St's frequently addressing M_s and keeping, at least verbally, in baby contact with M_s (Mumeey) seemed to make up for precocious identifications by holding on to earlier and safer ones, those of a baby.

As to the relationship of imitation and identification: J and St differed in their proclivity for imitation. John was not motivated to imitate whereas Stephen excelled in both verbal and performance tasks of imitation. Identification in John's case seemed to depend greatly on positive emotional ties when reproducing the mother's tone of voice or the father's ego ideal in his fantasy talk. In Stephen's case identification seemed more conflicted but also a function of (both positive and negative) emotional involvement.

E. SUMMARY AND IMPLICATIONS FOR FURTHER RESEARCH

The present study attempts to show that direct observation of pre-school children and parents in the home yet in a controlled situation, is feasible. Its merits lie in the naturalness as well as in the flexibility of the situation with regard to a specific research problem.

Observations of child and parent in their home were performed on a small sample, with particular attention paid to child-parent assimilation, i.e., the child's imitation of and identification with either parent. The home observation method seemed promising for the research problem at hand, as in each case certain characteristic assimilative patterns could be elicited. In each case there emerged modes of interaction between child and parent, which may be decisive for the course of assimilation.

The home observation method described here would seem useful for a variety of studies on interpersonal processes in the family; the understanding of an individual child would profit from knowledge of the interactional pattern to which it is exposed at home. The difference in these patterns for different sibs could be assessed in the same family. Clinical and non-clinical groups could be investigated as to interpersonal processes prevailing in their home situation. The method would seem to lend itself to socio-anthropological studies of child-parent interaction typical for a cultural group. For each particular problem the method would have to be modified in such aspects as the restrictions placed on the sample, and the selection of tasks.

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A CROSS-SECTIONAL AND LONGITUDINAL STUDY OF THE EFFECT OF EDUCATION ON FREE ASSOCIATION RESPONSES*

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A. INTRODUCTION

Research studies in the area of discrete free association have isolated several factors which influence the responses given on a free association test. Responses have been found to vary with age (10), sex (3, 4, 17), education (1, 11, 18), intelligence (2, 13, 14), personality (6, 8, 16), attention (4), pathology (7, 9, 12), amount of practice (5, 15), and familiarity with the language (5). The present study concerns itself with the effects of only one of these factors—education upon the individuality of responses given on a free association test. Previous studies of the effects of education have divided subjects into groups of "more" or "less" education and compared the responses of grade-school educated subjects with those of college-educated subjects. In so doing, the factor of intelligence was not sufficiently controlled since it is generally the more intelligent subject who seeks "more" education. The present study in employing matched groups has attempted to control the factor of intelligence while investigating the effect of education upon the individuality of associative responses as judged by both a cross-sectional and a longitudinal study.

B. CROSS-SECTIONAL STUDY

1. *Subjects*

The subjects used in the study were freshmen and senior undergraduate students enrolled in a private liberal arts college for women. The subjects were relatively homogeneous in socio-economic background.

2. *Tests*

The Kent-Rosanoff Free Association Test was employed and the Otis Self-Administering Test of Mental Ability, Higher Examination, Form A.

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Mimeographed booklets for the Free Association Test were specially designed to include a copy of the instructions to be read to the students, ample space for the recording and later coding of associations, as well as a numbering system to facilitate the use of IBM punch cards.

3. *Procedure*

The freshmen and the seniors were tested in separate groups on the same day at the beginning of the semester. The Otis Test was administered first, followed by the Free Association Test.

The Otis Tests of Mental Ability were scored and the resulting *IQ* scores were used to equate the freshmen and senior groups on a basis of intelligence in order to study the effect of education on free association responses without the influence of intelligence. The freshmen and seniors were equated in a person to person matching. The range of *IQ* scores for the groups was from 99 through 132 with the median at 117. This procedure resulted in matched groups of 136 freshmen and 136 seniors.

In dealing with the responses given on the Free Association Test several scoring methods were employed.

a. Individual responses—.001 Criterion. Traditionally, a free association response was considered to be individual if it was not found to be listed on the Kent-Rosanoff Frequency Tables (5). This same scoring procedure was employed in the present study. According to this scoring method then, a response was considered to be individual if it occurred less frequently than once in one-thousand responses. Thus the .001 level was used as the criterion of individuality.

b. Individual responses—.01 Criterion. In this scoring method statistical frequency was again employed as the criterion for the individuality of an associative response. However, it was felt that the Kent-Rosanoff criterion of less than one in a thousand was far too generous a measure of individuality. Therefore, according to this second scoring procedure a response was considered to be individual if it occurred less frequently than once in one-hundred responses. Thus any response with a frequency of less than ten on the Kent-Rosanoff Tables was considered to be an individual response thus setting the criterion for individuality at the .01 level.

c. Popular KR responses. In dealing with the concept of individuality one might anticipate that subjects who gave many individual responses could also be expected to give few of the responses which occur frequently. Individuality then might be inferred from the number of popular responses which are given by a subject. The third scoring procedure takes this hypothesis into consideration and considers as popular those responses which occurred first, second, or third most frequently in the Kent-Rosanoff Frequency Tables.

d. Popular Schellenberg responses. As indicated above, the Kent-Rosanoff Frequency Tables are generally employed as the standard list against which associative responses are compared in order to determine their frequency. The subjects employed for the compilation of these tables were drawn from varied educational backgrounds and subsequent studies have shown that education tends to influence free association responses. Since the subjects employed in the present study were drawn from a relatively homogeneous educational background (college students) the fourth scoring procedure made use of the Schellenberg Frequency Tables (12) which were compiled from the responses of college students. In this instance, a response was considered to be popular if it was listed as first, second, or third most frequent according to the Schellenberg Tables.

4. *Results*

The means, standard deviations, and ranges of the four association scores for the freshmen and senior groups are presented in Table 1.

It is noted in Table 1 that the seniors obtained a higher mean score and a larger standard deviation for both categories of individual responses. The seniors, then, judging both by average score and by group variability were more individual than the freshmen. Inversely, popularity of responses was not so strong in the seniors as it was in the freshmen.

TABLE 1

MEANS, STANDARD DEVIATIONS, AND RANGES OF SCORES FOR FRESHMEN AND SENIORS

Association scores	Freshmen Mean	Freshmen *SD*	Freshmen Range	Seniors Mean	Seniors *SD*	Seniors Range
Individual responses .001 Criterion	8.4	6.1	0–30	10.3	7.2	0–33
Individual responses .01 Criterion	23.0	10.4	6–56	26.0	11.2	5–63
Popular KR responses	51.9	12.0	19–72	50.4	12.2	16–77
Popular Schellenberg responses	54.9	11.1	19–79	52.6	12.5	16–76

TABLE 2

CRITICAL RATIOS OF MEAN DIFFERENCES BETWEEN FRESHMEN AND SENIORS

Individual responses .001 Criterion	Individual responses .01 Criterion	Popular KR responses	Popular Schellenberg responses
3.57**	3.49**	1.06	2.46*

** Significant at 1 per cent level.
* Significant at 5 per cent level.

Table 2, which contains the critical ratios of the mean differences of the freshmen and the seniors points to the significance, at the .01 level of confidence, of the difference between the number of individual responses given by the groups.

It has been noted that the freshmen tended to produce more popular responses than the seniors. However, when popularity was measured in terms of the Kent-Rosanoff Tables the mean difference was not found to be significant. In both groups there was found to be a greater number of Popular Schellenberg Responses than Popular KR Responses. This result was to be expected, however, since the Schellenberg Frequency Tables were compiled from the responses of college students. This fact could also account for the fact that when popularity was measured in terms of the Schellenberg Tables the mean difference between the groups was found to be significant at the .05 level of confidence.

When comparing freshmen and senior subjects it was thus possible to conclude that education significantly influences the individuality of associative responses.

C. Longitudinal Study

1. *Subjects*

One hundred of the students who were tested at the beginning of their freshmen year in college and who were included in the Cross-Sectional Study were again available for testing three years later at the beginning of their senior year in the same college.

2. *Procedure*

The Free Association Test was readministered to these 100 subjects and scored according to the four methods indicated above. The Otis Test was eliminated from this study since the same subjects were tested as freshmen and as seniors. The Free Association Scores of the subjects at the beginning of their freshmen year were compared with their scores at the beginning of their senior year.

3. *Results*

In Table 3 will be found the means, standard deviations, and ranges of association scores for 100 students as freshmen and the same one hundred students as seniors.

The critical ratios of the mean differences between the association scores of the students as freshmen and as seniors are to be found in Table 4.

TABLE 3
MEANS, STANDARD DEVIATIONS AND RANGES OF SCORES FOR 100 STUDENTS AS FRESHMEN AND AS SENIORS

Association scores	Scores as Freshmen Mean	*SD*	Range	Scores as Seniors Mean	*SD*	Range
Individual responses .001 Criterion	7.6	5.7	0–25	9.8	6.4	0–40
Individual responses .01 Criterion	21.5	9.7	6–48	25.9	10.8	8–68
Popular KR responses	54.2	10.8	19–72	50.3	11.4	15–70
Popular Schellenberg responses	56.7	11.7	24–79	52.4	11.4	18–72

TABLE 4
CRITICAL RATIOS OF MEAN DIFFERENCES AMONG 100 STUDENTS

Individual reponses .001 Criterion	Individual reponses .01 Criterion	Popular KR reponses	Popular Schellenberg reponses
3.70**	4.63**	3.92**	3.93**

**Significant at 1 per cent level.

Table 4 reveals that the same subjects when tested as freshmen and as seniors gave significantly different scores on the Free Association Test. The Longitudinal Study, then, substantiates and reinforces the conclusions drawn from the Cross-Sectional Study namely, that education is a significant factor in studying the individuality of free association responses.

D. CONCLUSIONS

The findings of this study substantiate the work of previous investigators in finding that more educated subjects have less popularity and more individuality in their free association responses than do less educated subjects. This study, however, goes further in its conclusions. It is possible, on the basis of a longitudinal as well as a cross-sectional approach, to show that three years of a college education results in substantially significant differences in the degree of individuality of free association responses. College seniors produce significantly more individual and fewer popular responses than do college freshmen. It is further possible to conclude that the differences which were found were due to the effects of education, and not to a combination of education and intelligence since variations in intelligence were controlled.

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A DEVELOPMENTAL STUDY OF GROUP PROCESSES*

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A. INTRODUCTION

The recent psychological literature reveals an active interest in the search for typical stages in the development of discussion groups of specific types including those devoted to problem solving (1, 4, 8, 12), therapy (10, 14), and human relations training (3, 11). However, there seem to have been no attempts to compare and contrast discussion processes that characterize groups at different age levels. This is consistent with the observation made by Yarrow and Yarrow that, "One looks in vain for evidences of a vigorous developmental social psychology to parallel the advances in the field of social psychology in general" (15). It would seem worthwhile to trace out some of the developmental changes that occur in the problem solving behavior of discussion groups not only because of their intrinsic importance for developmental social psychology but in the hope that they might provide new perspectives and increased understanding of the functioning of adult discussion groups.

B. PROBLEM

Of primary interest in this initial study was the pattern of interrelationships among the members of a group who were given the task of working collaboratively on a problem. The hypotheses that were tested were derived from observations made of changes that occurred in the history of single groups and changes noted in cross-sectional studies of the social behavior of children.

Observation of the early stages of development of a number of essentially leaderless groups concerned with examining their own behavior in order to extend their knowledge of groups and of themselves as individuals reveals tendencies to be apparently unresponsive to the contributions of others (13). There are frequent references to the nature of the problems that are pre-

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venting progress, to the possible solutions to the group's difficulties and to other relevant matters but these are generally not responded to and are even accepted as new contributions when they reappear much later in the history of the group. Those evaluative remarks that do occur in response to contributions of others are preponderantly negative in character. Furthermore, there are efforts to avoid the task by discussing topics unrelated to the understanding of the behavior of the assembled group.

In the later history of such groups there appears to be much more responsiveness to and acceptance of the contributions of others as evidenced by an increased seeking for information, the elaboration of the proposals of others, etc.

These findings would seem to parallel in some respects those reported by investigators who have observed the spontaneous behavior of children and who report that young children tend to be independent and egocentric (7, 9). "They behave simply as a number of independent persons, each mainly concerned with his own immediate ends, whether or not these ends cut across or chime in with the pursuits of others" (9, p. 213).

With an increase in age one can observe a trend toward "more developed and reciprocal social relationships with a settled organization" (9).

As a result of the observations noted above the following hypotheses were formulated. (*a*) The proportion of the total interactions that are devoted to task oriented remarks will increase as a function of chronological age. (*b*) The extent of independence of group members as opposed to their interdependence will decrease as a function of chronological age.

C. METHOD

1. *Subjects*

In this research it was necessary to make certain that the groups examined at the various age levels were comparable with respect to such variables as the degree of transiency, the intelligence of its members, group size, and group composition.

The requirement concerning degree of transiency was met by working only with ongoing groups in which there had been some opportunity for the subjects to interact. At the lowest age levels six groups of children were selected from the University Nursery School. The tasks were presented in May, guaranteeing a long period of prior association among the children. At the next age level four groups were selected from the Brownies and Cub Scout dens. The children who were subjects had been members of the same Scout groups for an extended period. At the third age level five groups were selected from Girl Scout and Boy Scout troops and had a similar history of prior association. Finally, the five oldest groups were selected from University classes that were taught by group discussion methods and that had been underway for a number of weeks.

The selection of specific individuals from these organizations was made on the basis of scores on intelligence tests with the exception of several cases in which scores were not available. The equivalence of the IQ scores derived from various tests could not be guaranteed. However, at least a crude matching of groups was possible.

The problems of group size and composition were dealt with by confining the investigation to groups of four like-sexed individuals.

TABLE 1
SEX COMPOSITION, AVERAGE *IQ*, N ON WHICH AVERAGE *IQ* IS BASED, AND AVERAGE CHRONOLOGICAL AGE OF EXPERIMENTAL GROUPS (IN MONTHS)

Group	Sex	$\overline{IQ}$	N_{iq}	$\overline{CA}$
NS-1	M	118	3	57
NS-2	M	110	3	57
NS-3	F	128	2	61
NS-4	F	123+	3	58
NS-5	F	n.a.*	—	50
NS-6	M	n.a.*	—	51
BR-1	F	112	4	111
BR-2	F	124	4	108
CUBS-1	M	113	4	108
CUBS-2	M	114.5	4	112
BS-1	M	131	4	160
BS-2	M	115	4	144
GS-1	F	107	4	146
GS-2	F	111.5	4	144
GS-3	F	111	4	157
Univ. I	F	n.a.*	—	448
Univ. II	F	115	3	263
Univ. III	F	113	3	285
Univ. I	M	114	3	282
Univ. II	M	115	4	261

* Not available.

Table 1 presents the sex composition, average IQ, and average chronological age of each of the groups. In addition, the number of cases on which the average IQ is based is given.

2. *Task*

Each group of four subjects was required to work on two tasks in varying order. Each member of the group was presented with a photograph, relatively ambiguous with respect to action and setting. These persons were then requested to work together in developing a story about the picture which would embody the nature of the current event, the events out of which it developed, and the outcome. Either preceding or following this, they were informed that they were to see a film. Following its completion they were to be asked to collaborate in the development of a story about the events they saw. The Heider-Simmel movie was then shown. The discussion of each group was limited to 12 minutes and was recorded electronically. During the discussion, the role of the experimenter was restricted. He was permitted to repeat the most recent statement during a lull, to ask what else the subjects thought, etc., but was not allowed to guide or participate in the discussion.

3. *Coding*

The tape recording of each discussion was transcribed and the resulting transcriptions were analyzed independently by two or more coders. In the initial stages, records of agreement and disagreement were kept. In instances of disagreement the coders conferred, explained the rationale underlying their judgments, and then reached a joint decision.

The coding system employed was a modified form of one developed by the University of Kansas Research Team at the 1950 National Training Laboratory in Group Development. The categories with crude descriptions of each include:

1. *Initiation.* An idea is presented which provides a new direction or new element in a story.
2. *Reinitiation.* The reintroduction of an idea that occurred earlier in the discussion.
3. *Seek clarification.* A request for additional information.
4. *Clarification.* A response to a query or an unsolicited elaboration of an idea under consideration.
5. *Evaluation.* Acceptance or rejection of a colleague's comment or interpretation.
6. *Description.* Simple description of what is present physically in the photograph or film without reference to significance, implications, etc.
7. *Irrelevant.* Remark not concerned with the task in any sense.
8. *Repetition.* Simple parroting of other's responses. Resembles contagion rather than genuine agreement.

The final three categories are actually irrelevant with respect to the group's task.

When the coding was completed, each group could then be described in terms of the number and the proportion of the total interactions falling within each of the eight coding categories.

D. ANALYSIS AND RESULTS

1. *Reliability of Coding*

During the early stages of coding an effort was made to determine the amount of inter-coder agreement. The first section of the first transcript consisting of 37 interactions was coded by each of four judges independently and the frequency of complete concurrence was determined. In 26 instances or 70 per cent of the total cases, all four judges agreed. Following this, pairs of judges coded successive sections, each judge working independently. Agreement between judges ranged from 73 per cent to 87 per cent. These samples involving the codings of pairs of judges were then combined. Agreement in the coding of 155 interactions occurred in 83 per cent of the cases.

The extent of agreement would seem to be adequate. This is particularly true considering that the determination of the reliability of judgments was made during the first attempts to code interactions.

2. *Task Orientation as a Function of Chronological Age*

The first hypothesis proposed that a greater proportion of interactions would be task oriented in the older age groups. Task oriented interactions were defined as those that were classified as initiations, reinitiations, seek clarifications, clarifications, and evaluations. Task irrelevant interactions were categorized as repetitions, descriptions, and irrelevant remarks.

For each group the percentage of total interactions that were task oriented was determined.[2] The results from those groups comprising a given age level were then combined. The five age levels[3] employed were Nursery School (4 years), Nursery School (5 years), Brownies and Cubs, Girl Scouts and Boy Scouts, and University students. The findings are presented in Table 2. Casual inspection reveals a trend in the predicted direction. This relationship was quantified by reverting to data characterizing individual groups and determining the correlation between the average chronological age of the group members and the proportion of their total reactions that involved task oriented behavior. For 20 groups the correlation (rho) was $+.64$ ($P \cong .01$). If the two groups of four year old nursery school students who differ so markedly from the remaining groups are excluded the correlation is reduced to $+.45$ which just fails to achieve significance ($P < .10$).

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[2] Inspection revealed a high degree of similarity between the patterns obtained from the discussion of the Heider film and those obtained from the discussion of the photograph. The decision was made to combine the data. In all of the analyses the composite patterns were used.

[3] Differences between the four and five year old children were dramatic. As a result, these groups were kept separate.

The hypothesis is supported by this analysis, though the strength of the relationship through the age range of 5-37 years is not sufficient to provide statistical significance.

TABLE 2
THE OCCURRENCE (IN PERCENTAGES) OF TASK RELEVANT AND TASK IRRELEVANT BEHAVIOR IN FIVE AGE GROUPS

	Age Group				
	Nursery School (4 years)	Nursery School (5 years)	Brownies-Cubs	Girl Scouts-Boy Scouts	University Students
Task relevant	25	87.5	87	90.4	97.4
Task irrelevant	75	12.5	13	9.6	2.6

3. *Independence, Interdependence, and Chronological Age*

The second hypothesis states that the extent of independence of group members as opposed to their interdependence will decrease as a function of increasing chronological age. The problem of defining independence and interdependence is difficult. It is possible to describe a series of measures that would reflect the extent of independence and interdependence in a group, though individually these measures are most imperfect. In order to get a crude estimate of the tenability of this hypothesis, several such crude measures were employed.

It was reasoned that in groups composed of relatively independent persons many of the interactions would involve the introduction of new ideas, new directions of development, rather than direct responses to the contributions of others. If this is correct, one could deduce from the hypothesis that a negative correlation would exist between average chronological age and the proportion of the total interactions that were classified as initiations. A correlation coefficient (rho) was computed for 18 groups[4] and was found to be —.63 ($P < .01$).

It is also possible to argue that interdependence, insofar at it involves responsiveness to others, would be reflected in the proportion of the total interactions that involved clarifications (though some clarifications are not in response to the initiations of others). This would lead one to conclude that a positive relationship exists between the proportion of the total intercations that are clarifications and average chronological age. The correlation (rho) is found to be +.70 ($P < .01$).

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[4] In this and subsequent analyses the two groups of four year olds were excluded. Their interactions were preponderantly task irrelevant. Since the hypothesis is concerned with task relevant behavior as reflected in these analyses their inclusion would introduce a distortion of the category percentages as a measure of independence.

Moreover, interdependently oriented individuals would more frequently express this orientation in a seeking for clarification than would independently oriented individuals. Our basic hypothesis would then lead to the prediction that average chronological age would be positively related to the proportion of the total interactions that were devoted to the search for clarification. The correlation between these two variables is found to be +.81 ($P < .01$).

Finally, interdependence among group members might be manifested by a willingness to accept the contributions of others. If this reasoning is defensible and if the original hypothesis is correct, one would deduce that positive evaluations would be encountered more frequently in groups of older individuals, negative evaluations would be encountered more frequently among groups of younger individuals. This was tested by correlating average chronological age with a variable defined as the proportion of positive evaluations minus the proportion of negative evaluations. The correlation is found to be +.77 ($P < .01$).

These results are all consistent with and lend credence to the hypothetical relationship between independent-interdependent orientation and chronological age.

E. Discussion

A relatively clear picture of some of the changes that occur in groups of increasing chronological ages emerged from the results. Very young groups (4 years) tended to devote the major portion of their time to matters other than those involved in the task set by the instructions. Such non-task oriented comments ranged from those completely extraneous to the situation ("I have a sled at home."), through those that were mechanical repetitions of the immediately preceding statement, a finding also reported by Bott (5), to those that were directed toward the photograph or film but were purely descriptive. Groups of increasing age confined their comments more and more to the task at hand.

Consistent trends in patterns of task relevant interactions were also evident. Groups of five year old children devoted more than half of their interactions to the introduction of new ideas with no particular attempt being made to coordinate the ideas. The subjects seemed to find it impossible to achieve consensus or to recognize lack of consensus as a problem. Actually very little elaboration of individual proposals was sought or provided. As a result no common theme emerged and the task could not be solved. When responsiveness in the form of evaluation occurred, it was very likely to involve rejection rather than acceptance. In other words, subjects tended to maintain their individual autonomy and to treat others as obstacles rather than as potential collaborators.

With increasing age, group members became more capable of working cooperatively, which involved the surrendering of some autonomy through compromise. Though no single story was likely to be developed in the time available, proposals were reacted to more frequently by an exploration of their possibilities through elaboration and a search for clarification. This form of willingness to accept another's idea at least tentatively was paralleled by an increasing tendency to make accepting rather than rejecting judgments of other's contributions.

The impressions conveyed by these findings closely resemble in certain respects those obtained from a reading of the reports of Isaacs (9). Younger children did behave "as a number of independent persons," whereas older groups tended to manifest "more developed and reciprocal social relationships." Furthermore, the trends noted have also been observed in the play activities of children (6). Early play is individual and independent in nature, later developing into socially organized forms with the earliest of these social forms involving imitation.

The findings were also consonant with the observations made of the development of groups in classes in group dynamics (13). They, furthermore, parallel in part the stages of development in training groups described by Bennis and Shepard (3) and the phases of therapy group development as described by Martin and Hill (10).

It has been noted that some of the early behavior of adult discussion groups resembles in form the behavior of discussion groups composed of children. This observation in conjunction with the work of Barker, Dembo, and Lewin (2) suggests the possibility that groups at a given age level when frustrated might regress and thereby display behavior characteristic of a younger age group. Some presumptive evidence for this hypothesis can be derived from a longitudinal study of a T-group at the National Training Laboratory in Group Development. This group met for two hours each week day for a period of three weeks. The discussions were recorded on Days 3, 5, 8, 10, and 13. Later they were transcribed and coded using essentially the same coding system described above.

The general impression obtained in observing the group was that in its initial meetings its activities were rather conventional but not productive. There was increasing concern for the lack of progress but conventional approaches (attempt to develop an agenda, search for a goal, etc.) continued to be employed with a similar lack of success. By the middle of the second week the content of the discussion was concerned more frequently with feelings and problems of interpersonal relations. By the end of the second week, the group began to pull together again with the focus shifting away from the group's affective problems which had been resolved in part. This was accompanied by an increase in the feeling of unity and accomplishment.

The data derived from coding appear in Table 3. They reveal that during the first week while continued failure was experienced there was a sharp drop in clarifications (a decrease of 36 per cent) and a corresponding increase in the occurrence of initiations (an increase of 121 per cent). It should be recalled that the interval treated is not the entire week but only the period from the third to the fifth day. Following this, the trends were reversed. By the time of the 13th meeting (while group members are reporting greater achievement and cohesiveness), the proportion of initiations is reduced to a point below the initial level and clarifications account for more than 60 per cent of the total interactions. The trends in the category "seek clarification" appear to be unrelated to the other trends or to the gross description of the group.

TABLE 3
PERCENTAGE OF TOTAL INTERACTIONS DEVOTED TO EACH OF THREE CODING CATEGORIES FOR EACH OF FIVE DAYS SAMPLED (T-GROUP AT NTL)

	Day				
Coding category	3	5	8	10	13
Initiation	10.5	23.2	13.9	8.7	6.5
Clarification	44.2	28.4	32.2	48.4	60.4
Seek clarification	12	10.8	19	15.4	14.8

These results seem to provide some evidence for the appearance of regression under conditions of frustration. However, it is obvious that the rationale is highly inferential. A genuine experimental attack on the problem would seem to be required.

Much work remains to be done in the clarification of the two constructs, independence and interdependence. The crude measures employed in this study might then be replaced by much more effective measures.

Moreover, task variables are undefined and the developmental trends reported can at best be accepted only in the context of the two tasks employed in this investigation.

F. SUMMARY

The present study was concerned with examining developmental trends in group problem solving processes.

Twenty groups of four individuals each ranging in average chronological age from 50 months to 448 months were drawn from larger groups. These large groups had been in existence for an extended period of time guaranteeing prior association among the members of the experimental groups. These larger groups were the University Nursery School, Brownies and Cub Scouts, Boy Scouts and Girl Scouts, and University classes. Each experimental group was homogeneous with respect to sex. An effort was made to obtain groups having roughly equivalent average intelligence quotients.

Each group was confronted with two tasks, similar in that each required the group to work collaboratively in developing a story about an event depicted, including its origins and the outcome. The stimulus materials, an ambiguous photograph of a running child and the Heider-Simmel movie, were presented in varying order.

The ensuing discussions were recorded and transcribed. These transcriptions were then coded into a set of categories. Inferences were made concerning the frequency of use of the various categories and the relation to a task-relevant orientation and to independent-interdependent orientations.

Within the context of the study the following hypotheses were supported: (*a*) The proportion of the total interactions that are devoted to task oriented remarks will increase as a function of chronological age. (*b*) The extent of independence of group members as opposed to their interdependence will decrease as a function of chronological age.

The resemblance of these findings to reported observations of the social development of children and the stages of development of individual discussion groups and therapy groups was noted.

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TRANSFER BY NORMAL AND CHRONIC WHOLE-BODY IRRADIATED MONKEYS OF A SINGLE LEARNED DISCRIMINATION ALONG A PERIPHERAL CUE GRADIENT*

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A. Introduction

The preponderance of studies (6, 10, 11, 15, 16, 17, 29, 32, 33) of the debilitating effects of whole-body ionizing radiation on learning and retention by primates has found negative results. Only two studies (14, 39) have reported learning deficits in the monkey as a consequence of radiation exposure. In a number of studies (10, 23, 24, 25, 32) irradiated monkeys have shown superiority in performance to nonirradiated monkeys. A performance facilitation accruing to radiation exposure has also been noted by Blair and Arnold (2) in the rat.

The phenomenon of facilitation of learning performance on certain tasks as a latent effect of radiation exposure seems well established. It seems probable that this performance facilitation is a direct resultant of chronically decreased distractibility (22) and the consequent narrowing of attention (4, 31).

As McDowell and Brown (23) have pointed out, the concept of facilitation of learning performance by debilitation is not new. As early as 1920, Lashley (18) found the initial learning of a light-dark discrimination by partially decorticated rats to be superior to that of normal rats both in terms of trials and errors. Brogden and Culler (3), in 1937, used conditioned response technics to measure absolute loudness thresholds in dogs and found a transitory gain in acoustic sensitivity following X-irradiation. More recently, Wade (37) showed that the prefrontal monkey under Dial or Nembutal administration regains the ability to perform above chance level on delayed response problems.

Wade's results have been interpreted by Stanley and Jaynes (36) to mean that one physiological consequence of sedation is an elevation of all of the

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response thresholds to the many stimuli constantly surrounding the animal to the same degree. The potentialities of the weaker stimuli for provoking responses are, then, lost and only those responses with the greatest habit strengths are provoked; i.e., the well learned responses to the baited foodwells.

An analogous interpretation might be made of the effects of irradiation on the learning performance of the monkey. The decreased responsiveness to the weaker stimuli by the irradiated monkey appears reflected in facilitation of learning performance on the delayed response type problem just as is the sedation effect in the prefrontal animal. It would seem, however, that the point of departure for facilitation in the irradiated monkey is from the response threshold values of the normal monkey rather than from the presumed lowered response threshold values of the prefrontal monkey.

If it is concluded, then, that the irradiated monkey focalizes his attention on the baited foodwells, the question arises as to whether he thereby learns more about the stimuli or signs leading to the food reward than does the normal monkey when both have experienced the same number of reinforced trials. The answer to this question constitutes the purpose of the present study.

B. PROBLEM

The task designed to determine whether the irradiated monkey learns more than the normal monkey in the same number of reinforced trials was that of the transfer of a simple learned discrimination along a peripheral cue gradient—a task which obviously involves varying degrees of spatial discontiguity between the stimulus objects and the site of food reward.

Aristotle's principle of association by contiguity, as originally formulated (9), stressed both temporal and spatial contiguity. Research work in recent years has tended to neglect the second of these two factors, but it has retained temporal contiguity as a valuable theoretical construct and experiment variable.

One of the few recent studies dealing with the factor of spatial discontiguity was reported by McClearn and Harlow (20). They trained four monkeys on a discrimination problem with vertical separations of 0, 1, 2, and 4 in. between the cue stimuli and the site of response (the site of food reward being spatially contiguous with the site of response). Each *S* was given 64 trials per day for 20 days. Magnitude of spatial separation was found to be inversely related to efficiency of performance. The relative differences of performance between degrees of vertical separation became less with training, all performance curves leveling off at above 90 per cent correct responses.

Murphy and Miller (30) studied object-quality learning by rhesus monkeys as a function of spatial contiguity of cue and reward. Their monkeys were completely unable to acquire the necessary discriminations when the stimulus objects were displaced vertically for a distance of 6 in. from the site of the reward. When animals that had formed learning sets under standardized conditions were exposed to the condition of spatial separation between cue and reward, their performance levels decreased significantly to chance levels.

A number of studies have inadvertently introduced the factor of spatial discontiguity. Andrew and Harlow (1), for example, trained monkeys to respond discriminatively on the basis of two different stimuli suspended by wires 2 in. above identical wooden bases. Learning was much less efficient than when comparable objects were put directly over the foodwells.

Gellerman (8) found two chimpanzees still unable to discriminate after 500 trials when the stimuli were on the fronts of two boxes and the *S*s were required to lift the appropriate box lid to procure a reward. After the stimuli were placed in positions adjacent to the box lids, the *S*s required about 50 trials each to learn to respond correctly.

Wodinsky, Varley, and Bitterman (40) used a four-window jumping apparatus to study discrimination learning in rats. Differential stimulus cards placed in the two end windows served as the cues to direct response in one condition. In the second condition, the rats were required to jump to the appropriate end window on the basis of differential cue cards placed in the center windows. The rats were more efficient in all tests requiring a direct jump to the differential stimulus card than in the tests requiring a jump to a card lateral to the differential cue card.

The method of the present study has in common with the above studies the factor of spatial discontiguity, but it seeks to determine, after a simple discrimination is well learned, how well the discrimination is maintained as the amount of separation between the differential stimuli and the site of food reward becomes increasingly greater. The choice of a simple stereometric discrimination problem practically assures an equivalent number of reinforced trials for control and experimental *S*s, since irradiated *S*s have never been demonstrated to differ significantly from control *S*s with respect to problems of this type. If the irradiated *S*s do in fact learn more about the stimuli or signs leading to food reward than do normal *S*s in the same number of reinforced trials, they should show more efficient performance than the normal controls as the cues become successively more discontiguous with the site of the food reward. Such a demonstration would give an affirmative answer to the problem of this study.

C. Materials and Methods

1. *Subjects*

Thirty-eight male rhesus monkeys, ranging in age from five and one-fourth to six and one-fourth years, served as *S*s. The training histories of the *S*s were roughly identical and included a wide array of discrimination tasks, delayed response training, tests of psychomotor coordination, patterned-string performance, food-preference studies, and visual acuity problems. None of the *S*s had experienced previous training on the utilization of peripheral cues to obtain food rewards.

Seventeen control and 21 experimental *S*s were used. The 21 experimental *S*s had been exposed to a mixed source of gamma and neutron radiation approximately three years before the present study was initiated. Four of the experimental *S*s (subsequently designated as the high-dose or HD-Group) had received a total radiation dose of 616 rep and four (subsequently designated as the intermediate dose or ID-Group) had received a total radiation dose of 308 rep. Five of the remaining 13 experimental *S*s (subsequently designated as the low-dose or LD-Group) had received a total radiation dose of 77 rep and eight a total radiation dose of 154 rep. The *S*s had initially been assigned to treatment groups on the basis of delayed response performance.

2. *Apparatus*

All testing was conducted in a modified version of the Wisconsin General Test Apparatus (subsequently designated the WGTA), the holding cage of which measured 36 x 30 x 24 inches. A grey painted stimulus tray holding two foodwells, spaced 12 inches apart center-to-center, was used for the simple discrimination training.

A modified two-string patterned string board, as shown in Figure 1, was designed for the peripheral cue testing. This string board was placed directly over the stimulus tray used in the simple discrimination training. The strings, pieces of plumber's chain, were attached in the front of the board to seated eyebolts and extended to behind a three-sided chimney in the rear center of the board. Small nails attached to the free ends of each length of plumber's chain were used to impale the food reward, a raisin, on the end of the appropriate chain. The three-sided chimney prevented the *S* from response on the basis of seeing which chain held the raisin. The peripheral cue positions were measured along the back of the board from the chimney to the edge of the board. The distances from the inner edge of the peripheral cue to the edge of the three-sided chimney were, from closest to remotest peripheral cue positions respectively, 1.125 inches, 3.375 inches, 5.625 inches, and 7.875 inches.

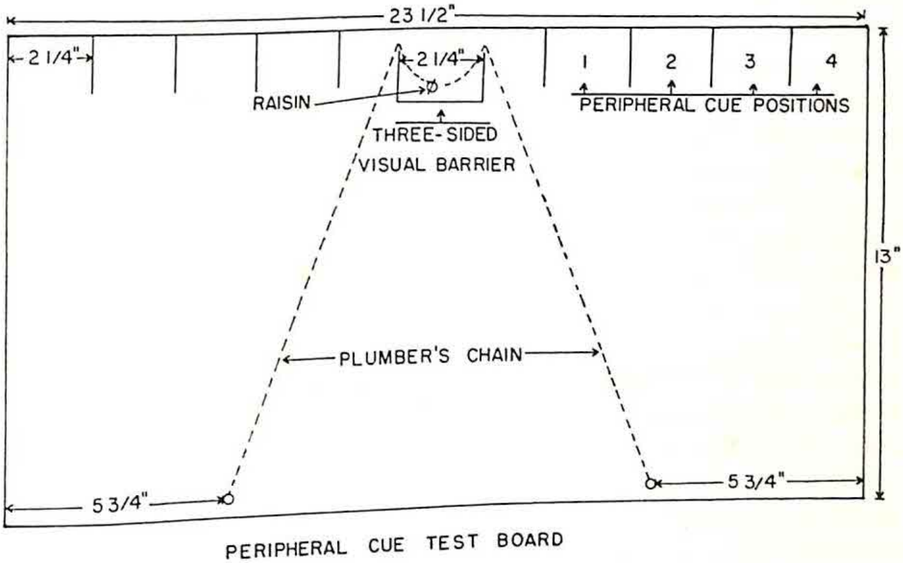

FIGURE 1
THE MODIFIED TWO-STRING PATTERNED STRING BOARD USED FOR THE PERIPHERAL CUE TESTING

The negative stimulus object was a black painted circular wooden block measuring two and three-eighths inches mounted flat on a white painted square wooden block measuring 3 x 3 x ⅝ inches. The positive stimulus object was a red painted triangular (isosceles triangle) wooden block with a base of two and three-fourths inches, an altitude of two and one-half inches, and a thickness of five-eighths inches mounted vertically on a red painted square wooden block measuring 3 x 3 x ⅝ inches.

3. *Training Procedure*

Each *S* was first tested 24 trials per day for five days on a single discrimination problem involving direct manual response to the wooden blocks covering the foodwells on the two-foodwell stimulus tray. Then each *S* was tested 24 trials per day for five days on each of the four peripheral cue conditions, the order of testing being from the least peripheral to the most peripheral condition of testing. This task required a manual response to a length of plumber's chain on the basis of the proximity of that chain to the stimulus object which had been rewarded in the simple discrimination training. The order of occurrence of randomly and constantly arranged blocks was randomized in the 24 trials presented to each *S* each day.

A simple discrimination trial was presented in the following manner. The opaque screen of the WGTA was lowered, ending the previous trial, and the two-foodwell stimulus tray was cleared. One raisin was placed in either the right or left side foodwell according to the predetermined random order. The two wooden blocks were placed simultaneously over the two foodwells, the positive block, of course, being placed over the foodwell containing the raisin. The one-way vision screen was lowered, the stimulus tray carrier advanced, and the opaque screen raised, allowing the *S* to make a choice. After the *S* completed the trial, the stimulus tray carrier was withdrawn from the reach of the *S*, the opaque screen lowered, and the next trial commenced. The *S* was allowed only one choice on each trial.

The peripheral cue testing differed from the simple discrimination training only in that the food reward was impaled on the end of a length of plumber's chain and hidden behind the three-sided chimney in the rear center of the modified string board and in that direct manual response to the length of chain on the side of the board holding the positive object of the simple discrimination training was rewarded rather than direct manual response to the object itself.

D. RESULTS

Figure 2 shows the per cent of errors made by each of the four groups on the simple discrimination training and on each of the four peripheral cue conditions. In Figure 2, the first condition is the simple discrimination problem, and Conditions 2 through 5 are the peripheral cue conditions from nearest to remotest, respectively.

The analysis of variance (7, pp. 315-22) of the error scores on the simple discrimination training yielded an F-value of 2.77. The groups, thus, failed to differ significantly with respect to error scores on this training. Since all *S*s were tested for the same number of trials and were rewarded only for correct responses, it follows that the groups also failed to differ significantly with respect to number of reinforced trials during this training.

Table 1 presents the results of the analysis of variance of the error scores over the four peripheral cue conditions. Since heterogeneity of variance was obvious on inspection of the raw data, a p value of .025 was arbitrarily required, as suggested by Lindquist (19, p. 86), before an effect was considered significant. The *p* value of .01 for the nonlinear *B* effect indicates that the hypothesis that all of the groups were in the same population is untenable

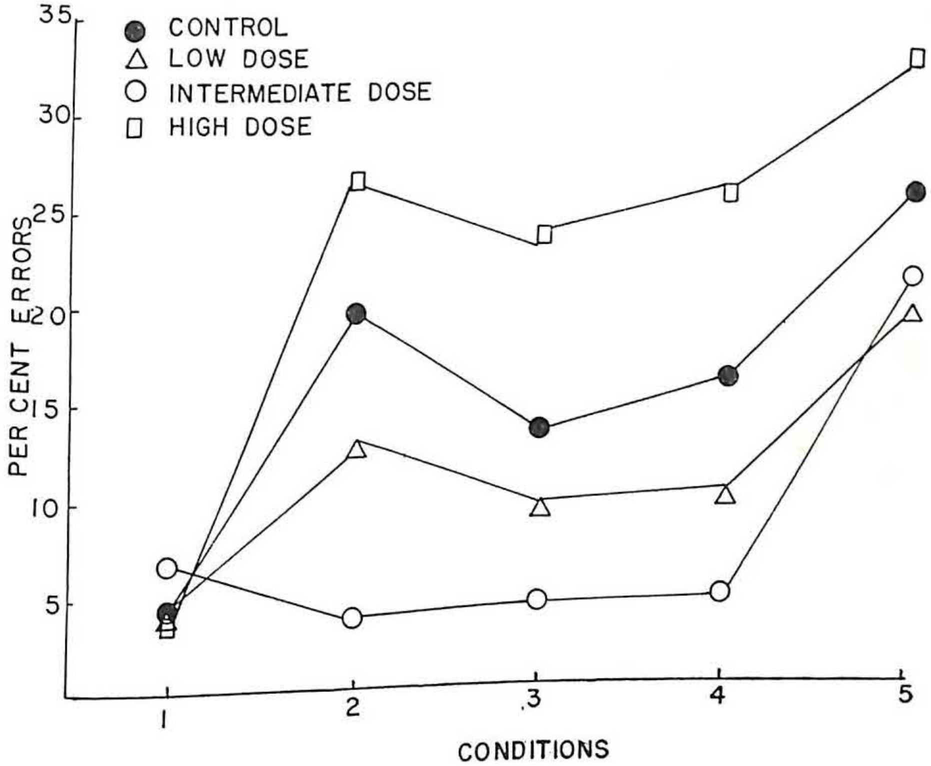

FIGURE 2

Per Cent Errors for Each Group on the Simple Discrimination Training and on Each of the Four Peripheral Cue Conditions

TABLE 1

Analysis of Variance: Peripheral Cue Conditions

Source	df	SS	MS	F	P
Between subjects	37	23113.25			
B (Groups)	(3)	(5980.92)	(1993.64)	(3.96)	.025
1. Linear	1	2.75	2.75	.01	NS
2. Nonlinear	2	5978.17	2989.08	5.93	.01
Error (b)	34	17132.33	503.89		
Within subjects	114	19420.69			
A (Conditions)	3	4557.70	1519.23	10.72	.001
AB	9	401.74	44.64	.31	NS
Error (w)	102	14461.25	141.78		
Total	151	42533.94			

and that the error scores varied as a nonlinear function of radiation dosage. The p value of .001 for the A effect shows that the error scores differed significantly as a function of conditions. The failure to obtain a significant AB interaction supports the tenability of the assumption that error scores of the groups were parallel over conditions.

E. DISCUSSION

The stated purpose of this study was to determine if the irradiated monkey, because of his demonstrated focalization of attention, has learned more about the stimuli or signs leading to food reward than has the normal control monkey when both have experienced the same number of reinforced trials. The experimental paradigm selected to investigate this problem was that of the transfer of a simple learned discrimination along a peripheral cue gradient. It was assumed that if the irradiated animal had learned more about the stimuli or signs than the control animal during direct response to the stimuli in the discrimination training, he would manifest more efficient transfer than the control animal to the peripheral cue condition, which involved a discriminative response to identical pieces of plumber's chain on the basis of the positive and negative stimuli of the simple discrimination training.

A single, simple answer to the problem seems contraindicated by the experimental results. Whether the irradiated monkey learns more about the stimuli leading to food reward than the control animal in the same number of reinforced trials appears to depend upon the radiation dosage under consideration.

The groups did not differ significantly with respect to number of reinforced trials on the simple discrimination training. When the groups were compared with respect to efficiency of performance on the peripheral cue conditions, they were found to differ significantly as a nonlinear function of radiation dosage.

These results are considered to indicate that, under the conditions of this study, the irradiated animal learns increasingly more in the same number of reinforced trials than the normal control animal as the radiation dosage is increased up to a point and that the increment becomes increasingly less as the dosage is increased beyond this point. The low-dose irradiated animals manifested a slight advantage over the control animals, the intermediate-dose animals manifested a greater advantage, and the high-dose animals showed no advantage at all.

The results of this and previously cited studies (10, 23, 24, 25, 32) conclusively demonstrate a facilitation of learning performance in the irradiated monkey with respect to certain tasks. Most researchers dealing with the radiation variable have directed their interests toward debilitating effects, and the few researches encountering facilitative effects have noted them only incidentally. The only programmatic study concerned with the facilitative effects of radiation on learning task performance has been conducted by the author and co-workers.

The decreased distractibility of the irradiated monkey as demonstrated by McDowell (22), with the consequent narrowing of attention reported by Brown, Carr, and Overall (4) and by Overall and Brown (31), would seem adequate to explain most of the reported facilitations of learning task performance in the irradiated monkey. With increased attention to the baited foodwells, the probability of correct response on both discrimination problems with reduced stimulus cues and on delayed response problems should be increased, as has been reported by McDowell and Brown (23) for the first of these two tasks and by Harlow and Moon (10) and by McDowell and Brown (24) for the second of these two tasks. Again, decreased distractibility would seem sufficient to account for the reported superiority of irradiated monkeys in learning difficult discrimination tasks as noted by Riopelle, Grodsky, and Ades (32).

Maier (27) has shown that inattention may be produced by repetition. It is likely that such a factor was operative in the significant increase in performance of irradiated monkeys over control monkeys on the fourth and fifth administrations of the oddity problem, as shown by Harlow and Moon (10). Examination of their performance curves on this problem indicates that the irradiated animals showed no facilitation in performance during the test administrations under consideration, but, rather, maintained the performance level of former administrations while the performance level of the control animals dropped below that of former administrations. These data, then, suggest that the irradiated monkey is more resistant to inattention due to repetition than is the normal monkey.

At first glance, the data of Warren, Kaplan, and Greenwood (39) suggest greater response perseveration in the irradiated monkey than in the control monkey. Their irradiated monkeys made significantly more errors on reversal training than did their normal monkeys. Such a response perseveration, were it present in the irradiated monkey, could account for facilitation of performance on discrimination problems with reduced stimulus cues and on delayed-response problems. McDowell and Brown (25), however, have suggested a possible artifact in data treatment to account for the results of Warren *et al.*, and have demonstrated that the chronic irradiated monkey actually shows significantly smaller negative savings scores on an oddity-reversal problem than does the control monkey. Increased response perseveration in the chronic irradiated monkey, then, seems contraindicated.

While decreased distractibility and increased resistance to inattention produced by repetition appear adequate to explain most of the problems on which the irradiated monkey is superior to the control animal, they do not suffice, considered alone, to explain the results of the present study. When the irradiated animal shows greater positive transfer of a simple learned discrimination along a peripheral cue gradient than does a normal monkey, an explanation in terms of focalization of attention to the site of food reward is not feasible. It would seem, rather, that an explanation must be sought in terms of differential values attached to the stimulus cues during the simple discrimination training—an explanation in terms of contemporary learning theory.

It would appear appropriate that any attempted theoretical interpretation of the results of this study in terms of contemporary learning theory should use a theory which considers the number of reinforced trials an important factor in learning. Accordingly, the learning theory utilized will be that of Spence (34).

Spence (34, p. 197) has suggested that reaction potential and hence response strength be defined as:

$$R = H \times (D + K) - I_t$$

where H (habit strength) is a function of N (the number of reinforced trials), D (drive) is a function of T_d (the time of deprivation), K (incentive motivation) is a function of N, T_d, and W_g (the amount of the reinforcer), and I_t (the inhibitory factor) is a function of N and T_g (the time of delay of the reinforcer).

A consideration of the groups of this study at the time of the test for transfer of the simple learned discrimination, in terms of the above definitions, would lead to the prediction of equal response strengths with respect to the stimuli of the first peripheral cue condition. The number of reinforced trials for each of the irradiated groups did not differ significantly from that of the control group. There was no essential difference in time of deprivation. Each animal had received a single raisin or piece of corn for every correct response, thereby equating the groups with respect to the amount of the reinforcer. Also, there was no essential difference in time of delay of the reinforcer.

It could be argued that, perhaps, irradiation acts physiologically to alter the amount of *D* built up per standard unit of time of deprivation. Were this the case, it might be assumed that the differential build-up of *D* would be reflected in differential amounts of locomotor activity, since Wald and Jackson (38) have demonstrated for the rat, at least, that increasing the time of deprivation increases the locomotor activity, and McDowell's (21) work indicates that monkeys deprived for 14 hours are significantly less active than when deprived for 23 hours. It will be recalled that Harlow and Moon (10) reported that radiation caused a significant decrease in activity which was proportional to the dosage received and that McDowell (22) found the chronic irradiated monkey to manifest less locomotor activity than the normal control monkey. Figure 3, based on the raw data of McDowell (22), compares the locomotor activity of the irradiated groups and eight of the control group animals of this study. Statistical analysis of the data of this figure shows that the hypothesis that the groups are from the same population is untenable (H = 7.8326, p = .05). Any advantage, then, due to a

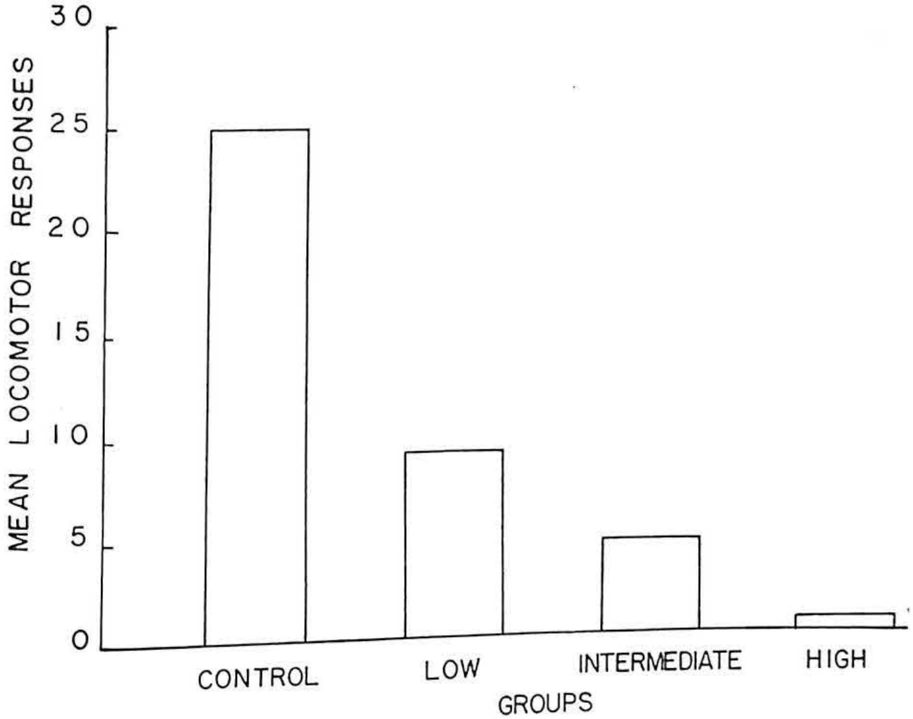

FIGURE 3
Locomotor Activity as a Function of Radiation Dosage

differential build-up of *D* should accrue to the greatest extent to the control subjects of this study. Such an advantage is not manifest.

Spence, although defining *K* as stated above for illustrative purposes, has stated that, ". . . considerable more research needs to be done before we can specify in a systematic and precise manner the experimental variables that effect *K*" (34, p. 136). This opens the possibility that some of these undetermined variables which effect *K* might account for the differences in response strength in the groups of the present study.

Spence (34, pp. 134-35) assumes the basic mechanism underlying *K* to be the R_g, the fractional conditioned response. According to Spence, Bergmann, and Lippitt (35), stimulus cues surrounding the goal object and leading up to the goal object are, with repeated trials, conditioned to the goal response. Then, by generalization, cues more distant from the goal object come to elicit components of the goal response which can occur in the absence of the goal object. This fractional conditioned response produces an interoceptive stimulus cue which becomes part of the stimulus complex leading to the goal and is conditioned to the motor responses instrumental in reaching the goal. The fractional conditioned response-interoceptive stimulus cue mechanism is also assumed to have motivational properties dependent upon the amount or intensity of its occurrence. Spence suggests that one way this mechanism might act to affect motivational level is to produce conflict and, in consequence, heightened tension. The heightened tension would lead to a heightened state of general drive level.

It would seem plausible to assume that the rate of emission of fractional anticipatory responses would vary with general drive level as do the rates of other responses. Thus, for the groups of the present study, the rates of emission of fractional goal responses should vary in a manner analogous to the variation in rates of locomotor activity. Were this, however, the only factor in the present study producing differential increments in *K*, the advantage in terms of response strength should again accrue to the control animals.

The range of effective stimuli, the number of stimuli above response threshold values in the test setting, might also be a determiner of *K*. Previous research has established that fewer of the stimuli in test situations comparable to the one of the present study are above response thresholds for the irradiated animal than for the control animal. It might, then, be hypothesized that the irradiated animal, in spite of a slower rate of emission of fractional goal responses, gradually increases his total *K* for a given stimulus over that of the normal animal, because more such fractional responses are conditioned to the appropriate stimulus cue as a consequence of his increased focalization of attention.

If, in terms of this hypothesis, the mean values of locomotor activity in Figure 3 (rounded to the nearest whole number to avoid fractionating a fractional response) are taken to represent the mean rates of emission of fractional goal responses for the various groups of this study, and arbitrarily defining K for each group as the ratio of mean correct responses per day for the group on the first peripheral cue condition to the mean correct responses per day for the least efficient group during the same period of testing, the theoretical range of effective stimuli for each group can be derived, the formula for the derivation being as follows:

$$\frac{\text{Fractional Anticipatory Response Rate}}{\text{Range of Effective Stimuli}} = \text{Incentive Motivation.}$$

Figure 4 presents the two empirical curves and the theoretical curve derived from them. The units assigned to the vertical scales are not to be construed as serving any other than an illustrative purpose. The figure is intended merely to show conceptually how the results of the present study could be explained in terms of rates of emission of fractional anticipatory responses and range of effective stimuli as determiners of K. In terms of this conceptual framework, it seems suggested that the range of effective stimuli varies as a negatively decelerated function of radiation dosage.

A more general hypothesis suggested by this study is that both the rate of emission of fractional goal responses and the range of effective stimuli, in an infinite population of stimuli, vary as positively accelerated functions of general drive level, with the positive acceleration per unit of general drive level being greater initially for the rate of emission of fractional goal responses than for the range of effective stimuli, but becoming less as high drive levels are reached; that the number of fractional goal responses to the appropriate stimulus cue is the determiner of incentive motivation and, in consequence, of response strength.

Two immediate implications of such a hypothesis are (*a*) that, with high general drive level held constant and the range of possible effective stimuli reduced, rate of growth of response strength should be increased and (*b*) that, with the range of possible effective stimuli held constant and high general drive level moderately reduced, rate of growth of response strength should be increased. Malmo's (28) work could be taken as a test of the first implication. He left drive level constant in the prefrontal monkey and produced improved performance on the delayed-response problem by reducing the room illumination, a procedure calculated to reduce the range of possible effective stimuli. Wade (37) left the range of potentially effective stimuli constant and improved the delayed response performance of the prefrontal monkey by administration of sedation. This work might be taken as illustrative of the second implication.

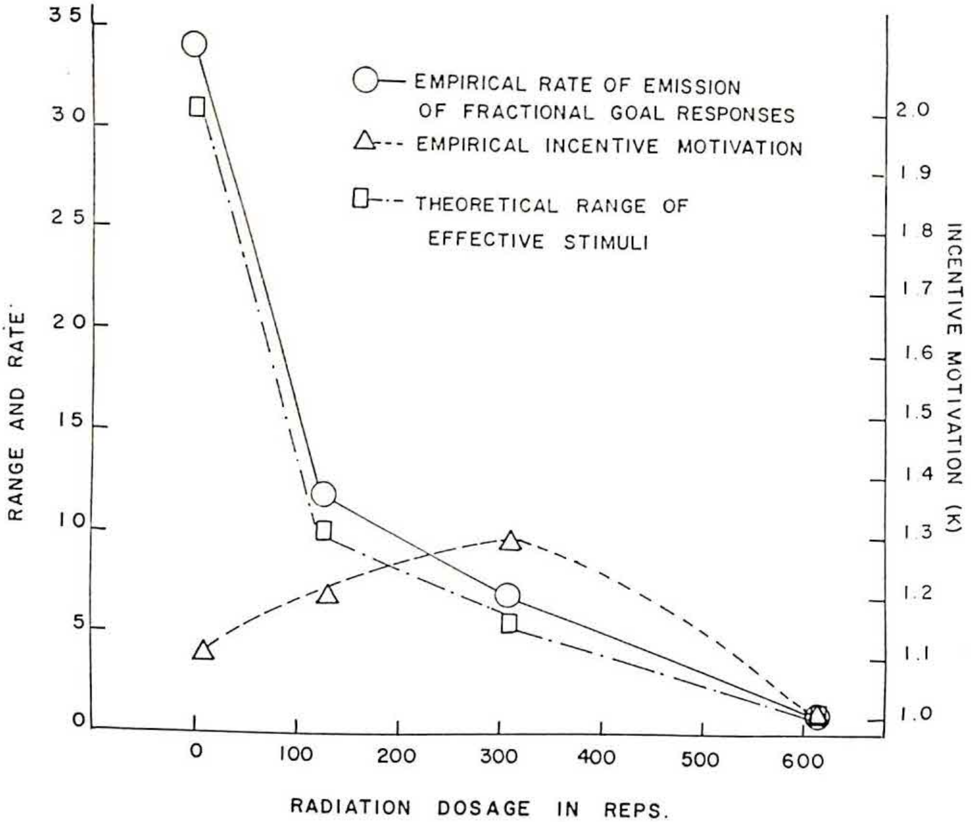

FIGURE 4
Theoretical Range of Effective Stimuli Derived from Dose Function Learning Performance and Locomotor Activity Curves

An additional implication of the above hypothesis is that, as the number of possible effective stimuli becomes less, the advantage of the intermediate drive level organism over the high drive level animal should disappear, and with further reduction the high drive animal should manifest the greatest rate of growth of response strength. In most simple instrumental reward conditions, response strength, according to Spence (34, p. 169), has been demonstrated to increase, up to a point, as a function of increased time of deprivation for the various need conditions. The situations used to demonstrate this increase have been simple in nature, providing a limited range of possible effective stimuli.

This hypothesis also implies that some minimal time of exposure of the relevant stimulus is necessary for growth of incentive motivation to occur. Recent findings of McDowell and Brown (26) support the reality of this implication. Monkeys trained under conditions of darkness during the delay period failed to solve 10-second spatial delayed-response problems in the time required by monkeys under constant light conditions to learn to solve these problems efficiently. In addition, monkeys which had learned to solve spatial delayed-response problems under constant light conditions lost their efficiency under conditions of intervening darkness during the delay period.

Bruner, Matter, and Papanek (5) have taken the position that strong motivation hastens learning with the sacrifice of narrowing it. Such a position could conceivably handle the data for the intermediate- and high-dose animals of the present study but could not account for the data of the low-dose and control animals.

Hebb (13, pp. 250-51) has considered, ". . . the relation of the effectiveness of cue function, actual or potential, to the level of arousal." He suggests that, as drive is increased, an optimal level of response and learning is reached and that, with increase in drive beyond this point, the level of effective response and learning gradually drops. The position of Bruner *et al.* could again adequately handle only the increase in effective behavior. The hypothesis developed in the present study could, however, handle both slopes of Hebb's curve.

F. Summary and Conclusions

Thirty-eight adult male rhesus monkeys were tested for transfer of a single learned discrimination along a peripheral cue gradient. Seventeen of these monkeys were control *S*s, 13 were low-dose irradiated *S*s, four were intermediate-dose irradiated *S*s, and four were high-dose irradiated *S*s. All irradiated *S*s had experienced whole-body exposure to a mixed source of gamma and neutron radiation approximately three years before the present study was initiated. The specific problem of the study was to determine if the irradiated animal learns more about the stimuli or signs leading to food reward than does the normal animal when both are given the same number of reinforced trials. The number of reinforced trials was held approximately constant by training the animals on a simple discrimination problem. Then, to determine if the irradiated animals had learned more than the control animals, all animals were tested for transfer of the learned discrimination along a peripheral cue gradient.

The results showed that low-dose irradiated monkeys manifest a slight advantage, intermediate-dose irradiated monkeys a greater advantage, and high-dose irradiated monkeys no advantage over normal monkeys with respect to transfer of a single learned discrimination along a peripheral cue gradient.

The advantage accruing to the irradiated animals was interpreted as reflecting differential increments in incentive motivation for the groups of the present study during the initial discrimination training. To explain these differential increments, it was hypothesized that the ratio of fractional anticipatory response rate to range of effective stimuli defines incentive motivation when the other determiners of incentive motivation, as given by Spence, are held constant. The more general hypothesis that both fractional anticipatory response rate and range of effective stimuli as determiners of incentive motivation vary as positively accelerated functions of general drive level, with the positive acceleration of fractional anticipatory response rates being greater at low and intermediate drive levels and less at high drive levels than the positive acceleration of the range of effective stimuli, was suggested.

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INTERVENING DARKNESS AND DELAYED RESPONSE PERFORMANCE BY RHESUS MONKEYS*

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A. Problem

Various hypotheses have been advanced to explain the performance of the monkey with lesions in the frontal lobes on the delayed response problem. Jacobsen's hypothesis of loss of immediate memory (2), Malmo's of increased susceptibility to retroactive inhibition (4), and Richter and Hines's of heightened distractibility (5) tend to emphasize the importance of the events occurring during the period of delay. Finan (1) and Riopelle and Churukian (6), by way of contrast, emphasize decrement in learning on the trial-setting phases of delayed response.

Since all of the above hypotheses suggest quantitative, rather than qualitative, differences between the frontal operant and the normal monkey, a resolution of the critical factor or factors in delayed response performance by frontal operants should be feasible with normal monkeys. If for instance, darkness during the delay interval in Malmo's study (4) were the only factor contributing to the superior performance of his operant monkeys, then, the performance of normal monkeys tested on delayed response problems with darkness during the delay interval should be better than that of normal monkeys tested on the same problems with regular room illumination maintained during the delay interval. The two experiments of the present investigation were designed to explore the tenability of this hypothesis.

B. Method

1. *Subjects*

Ten male rhesus (Macaca mulatta) monkeys were employed as *S*s in Experiment I. Five of the *S*s were assigned to the group (Group I) to be tested initially with darkness during the delay interval and five to the group (Group II) to be tested initially under regular room illumination. The training histories of these *S*s were identical and none of the *S*s had experienced prior training on delayed response problems.

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Three of the 10 *S*s of Experiment II were assigned to the group (Group I) to be tested with darkness during the delay interval and seven to the group (Group II) to be tested under regular room illumination. These *S*s, also, had identical training histories and no prior training on delayed response problems.

2. *Apparatus*

All training of *S*s in this experiment was conducted in a modified version of the Wisconsin General Test Apparatus (WGTA) with the *S*'s carrying cage serving as the holding cage for the test procedure. The stimulus tray of the apparatus held two food wells, spaced twelve inches apart center-to-center.

Identical square wooden blocks, painted yellow, served as the stimulus objects in Experiment I. Each of these blocks measured 4 x 4 x ¾ inches. The stimulus objects for Experiment II were a blue-painted square wood block, measuring 3-⅜ x 3-⅜ x 1-½ inches, and a circular red-painted wood block, with a depth of ¾ inches and a diameter of 3 inches.

3. *Procedure*

The direct method spatial delayed response technique was used for both experiments. A 10-second spatial delayed response trial was presented in the following manner. With the opaque screen of the WGTA raised, the attention of the *S* was drawn to the food reward which was placed in either the right-or-left-side food well according to a predetermined random order. The stimulus objects were then placed simultaneously over the two food wells. After a 10-second delay, the stimulus tray carrier was advanced and the *S* allowed to make a choice. For the *S*s tested under darkness during the delay, the light source, the overhead room light, was turned off immediately after placing the stimulus objects over the food wells and turned on immediately before advancing the tray carrier.

After the *S*s completed the first trial, the stimulus tray carrier was withdrawn from the *S*'s reach and the second trial begun. The *S* was allowed only one choice on each trial. Each *S* of Experiment I was tested 24 trials a day for 10 days and, then, the conditions of testing with respect to illumination were reversed for the next 10 days of testing.

Each *S* of Experiment II was tested 24 trials a day for 15 days with no reversal of illumination conditions. Each stimulus object of Experiment II retained a constant position throughout the period of testing. The position of reward was, however, randomized from trial to trial in the same manner as in Experiment I.

C. Results

1. *Experiment I*

The per cent of errors per group per day are presented graphically in Figure 1. The data show rapid decline in errors for the animals of Group II, the animals tested under regular room illumination, to an asymptote at slightly less than 20.0 per cent errors during the first 10 days of testing. The performance of the animals of Group I, the animals tested with darkness during the interval of delay, started at approximately the same level as that of the

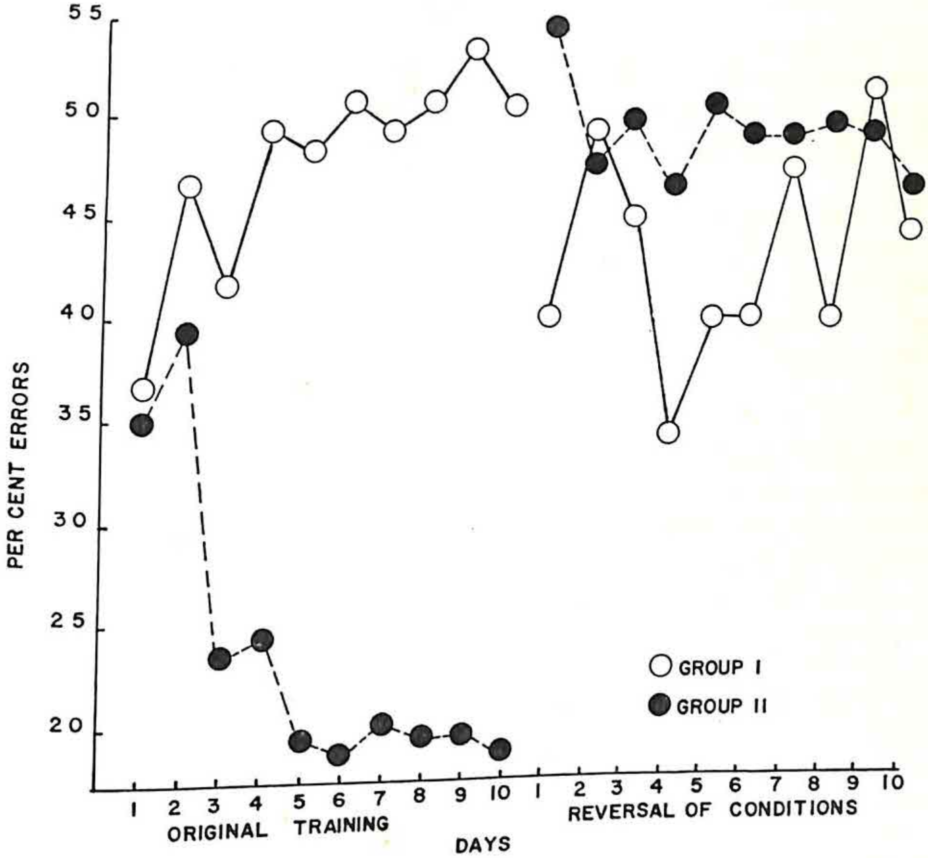

FIGURE 1

A comparison of per cent of errors per day on 10-second spatial delayed response problems involving identical stimulus cues by animals (open circles) tested for 10 days with darkness during the delay and, then, for 10 days under regular room illumination with per cent of error by animals (closed circles) tested on the same problems with the conditions of illumination reversed.

animals of Group II and, then, became progressively poorer during the same 10 days of testing. Statistical analysis of this data, using a groups-by-practice analysis of variance design, yielded (*a*) a difference between groups which was significant beyond the 0.1 per cent confidence level, (*b*) a practice effect which was not statistically significant, and (*c*) a groups-by-practice interaction which was significant beyond the 0.1 per cent confidence level.

When the conditions of testing were subsequently reversed for the two groups, the error scores of the animals of Group II rose immediately to chance levels and remained there throughout the 10 days of testing with darkness during the delay interval. The error scores of the animals of Group I improved but in an inconsistent manner, over their error scores during the intial testing. Statistical analysis of the data for this period of testing, using a groups-by-practice analysis of variance design, yielded a difference between groups which was significant beyond the 2.5 per cent confidence level. The F–ratios for practice and for the groups-by-practice interaction were not statistically significant.

The *t*-test was used to compare the performance of the animals of each group under the initial condition of testing with the animals of the same group when the condition was reversed. The performance of the animals of each group when tested under the conditions of regular room illumination was significantly superior beyond the 0.1 per cent confidence level to performance under the condition of darkness during the interval of delay.

2. *Experiment II*

The per cent of errors per group per day are presented graphically in Figure 2. The animals tested under regular room illumination decreased their error scores only slightly during the 15 days of testing while the animals tested with darkness during the delay interval decreased their error scores to zero by the 15th day of testing. Statistical analysis of this data, using a groups-by-practice analysis of variance design, yielded (*a*) a difference between groups which was significant beyond the 5.0 per cent confidence level, (*b*) a practice effect which was significant beyond the 0.1 per cent confidence level, and (*c*) a groups-by-practice interaction which was significant beyond the 0.1 per cent confidence level.

D. Discussion

The results of Experiment I of the present study are in direct contrast to Malmo's findings. Monkeys tested on direct method spatial delayed response problems using identical stimulus cues failed to manifest improvement in performance levels under conditions of darkness during the delay interval. The results of Experiment II, however, are in accord with Malmo's findings. Monkeys, in this experiment, tested on direct method spatial delayed response problems using discriminative, but ambivalent, cues improved their efficiency of performance significantly more under conditions of darkness during the delay interval than did monkeys tested on the same problems under conditions regular room illumination.

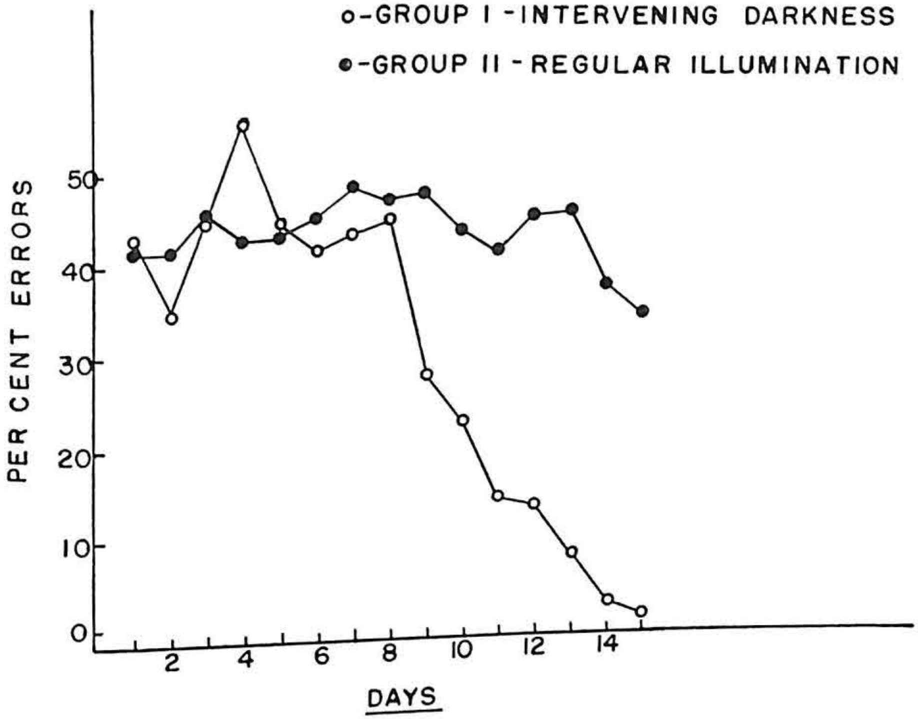

FIGURE 2

Facilitated spatial delayed response performance of monkeys tested on discriminative, but ambivalent, cue delay problems with darkness during the period of delay.

The present findings are interpreted by the authors as supporting both the importance of the events occurring during the delay interval and the learning during the trial-setting phases for delayed response performance by the monkey. In other words, if the trial-setting phase is such as to allow the formation of an association which will lead to subsequent successful performance, then the nature of interpolated stimulation becomes an important factor with respect to the subsequent performance.

A resolution in terms of conditioning of the contrast between the results of Experiment I of the present study with the results of Experiment II and Malmo's findings appears plausible to the authors. If delayed response depends, as Maier and Schneirla have suggested (3), upon recall rather than upon a response that has been held back or delayed, the animal, for successful solution, must merely have formed an adequate association during the trial-setting phase of the problem. In Malmo's study, for instance, where primary conditioning to a light was well established, the animals might have only to establish second order conditioning between the light source and specific features of the test apparatus spatially contiguous with the light source in order to manifest efficient recall—a process involving only one order of conditioning. In Experiment II of the present study, the animals might need only to establish first order conditioning between the food reward and the discriminative cue—a process involving, also, only one order of conditioning. The animals of Experiment I of the present study, however, might need to establish first order conditioning between the food reward and one of two identical cues and, then, second order conditioning between the appropriate cue and the spatially contiguous features of the test apparatus, a process involving two orders of conditioning. If, then, the duration of the trial-setting phase were not long enough to permit the evolution of two orders of conditioning, animals tested under the conditions of Experiment I of the present study, with darkness during the delay interval, would fail to manifest adequate recall.

The inefficient performance of the frontal operant monkey on direct method spatial delayed response, in terms of the above hypothesis, would be due to the failure of the animal because of lowered response threshold values (8) to evolve two orders of conditioning. That is to say, the hyperactivity (7) or heightened distractibility (5) of the frontal operant monkey may decrease the duration of the trial-setting phase just as does the imposition of darkness during the delay interval. Inefficient performance would, then, reflect a decrement in learning on the trial-setting phases of the problem rather than interference with what had been learned.

E. SUMMARY

Two experiments were conducted to determine the effects of intervening darkness upon spatial delayed response performance by monkeys. In one experiment, five *S*s were tested initially for 10 days on 10-second spatial delayed response problems utilizing identical stimulus blocks with darkness during the delay interval and, then, tested on the same problems for 10 days under conditions of regular room illumination five additional *S*s were tested

in the same manner with the exception that the conditions of illumination were reversed with respect to first and second 10-day periods of testing. In the second experiment, three *S*s were tested for 15 days with darkness during the delay interval on 10-second spatial delayed problems utilizing discriminative, but ambivalent, cues. Seven additional *S*s were tested for 15 days on the same problems under conditions of regular room illumination. The results were as follows:

1. *S*s tested on 10-second spatial delayed response with identical stimulus cues manifested no improvement in performance when darkness was maintained during the delay period.
2. *S*s that had learned to solve 10-second spatial delayed response with identical stimulus cues performed only at chance levels when subsequently tested under darkness during the delay interval.
3. *S*s tested under conditions of darkness during the delay interval on 10-second spatial delayed response problems with discriminative, but ambivalent, cues eliminated errors significantly faster than *S*s tested on the same problems under conditions of regular room illumination. Such *S*s, also, improved to errorless performance in contrast to the usual asymptote at between 80.0 to 90.0 per cent correct shown by *S*s tested with identical stimulus cues under regular room illumination.

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THE EFFECT OF GAMMA RADIATION ON THE REORGANIZATION OF A COMPLEX MAZE HABIT*

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A. PROBLEM

The research reported in this study was designed to investigate the effects of gamma radiation on the reorganization of a complex maze habit following whole-body irradiation. Interest in the general effects of exposing an organism to ionizing radiation dates back to 1928 (15), but only in the post-war period have systematic investigations been undertaken (1, 3, 4, 5, 6, 8, 9, 10, 11, 14, 16, 20). Most of these studies investigated the effects of ionizing radiation on learning and retention and found no significant decrement in performance with the dose ranges used. Although the literature indicates that exposure to radiation has no effect on learning and retention, there are several studies using dosages which apparently do not cause pathological deterioration that have been shown to cause (*a*) changes in general behavior (13), (*b*) changes in food preference (12), and (*c*) the development of a conditional avoidance response to saccharine (7).

In view of the negative findings from studies on learning and retention following exposure to ionizing radiation, it seems plausible that the problems designed for the *S*s were not sensitive enough to detect radiation effects. The present study was designed with this problem in mind. Such problem as the delayed response and oddity problem have already been studied and found not to indicate any difference between the performance of control and irradiated animals. The apparent area of performance that has been overlooked by most researchers is described by Settlage, Zable, and Harlow (18), and also by Warren, Kaplan, and Greenwood (20) in which discrimination-reversal problems are presented to monkeys. The same technique was also employed by Settlage, Butler, and Odoi (17) who interpret their findings as "amenable to the interpretation that the monkeys experienced difficulties, not because of the intrinsic complexity of the problems themselves, but rather because of the relation between a specific aspect of the animals' acquired

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[1] The authors are indebted to the Radiobiological Laboratory of the School of Aviation Medicine, Austin, Texas, for carrying out the radiation procedure on the animals.

mental organization and the nature of the problems with which it was faced. Difficulties arose when familiar situations suddenly required reorientation for successful adaptation" (p. 259).

B. METHODS

1. *Subjects*

Forty female rats from the Sprague-Dawley strain were used as subjects. At the beginning of the investigation, they were approximately seven months of age, and experimentally naive to maze problems.

The *S*s were housed in the colony room of the Comparative Psychology Laboratory of the University of Texas with seven *S*s to a large cage. The *S*s were brought into the experimental dome room individually and given one run daily. At the completion of a run the *S*s and the goal box were returned to the colony room, and the *S*s were permitted to eat in the goal box for 10 minutes. At the end of this period they were removed to another cage containing food and water for 50 minutes before being returned to their home cage which contained only water. Therefore, the *S*s were on a 23-hour food deprivation schedule with an *ad libitum* water schedule.

2. *Mazes*

Two elevated T-mazes were used in the investigation. The training maze duplicated the pattern of the well known Tolman-Honzik 14-unit maze (RLLRRLRRLRRLLR).

The pattern of the experimental maze was determined as to right and left correct turns from a table of random numbers (see Figure 1). The maze units were constructed of white pine and were 36 inches long, 2 inches wide and 24 inches high. The goal boxes were 8 x 8 x 8 inches with a ¼ inch hardware cloth bottom and a removable top through which the animal could be removed and food replaced. The doorway into the goal box was 2 inches wide and 4 inches high with a runner on either side permitting the insertion of a piece of aluminum to enclose the rat. The maze and goal boxes were painted "pearl gray."

The experiment was conducted in the Dome Room of the Comparative Psychology Laboratory of the University of Texas. The room is constructed to yield a homegeneous environment, thus eliminating extra-maze cues.

3. *Procedure*

a. Preliminary training. All *S*s were given one trial daily on the training maze. The *S*s were carried from their home cage and placed on the beginning of the starting section. Retracing was prevented by pulling back the unit behind the one on which the *S* was retracing. An error was recorded for entry into a cul; the time for transversal of the maze, from the time the *S* was placed on the starting section of maze until *S* entered the goal box, was also recorded.

The *S*s were run on the training maze until they reached a criterion of three or less errors on any one trial, at which time they were transferred to one of four groups.

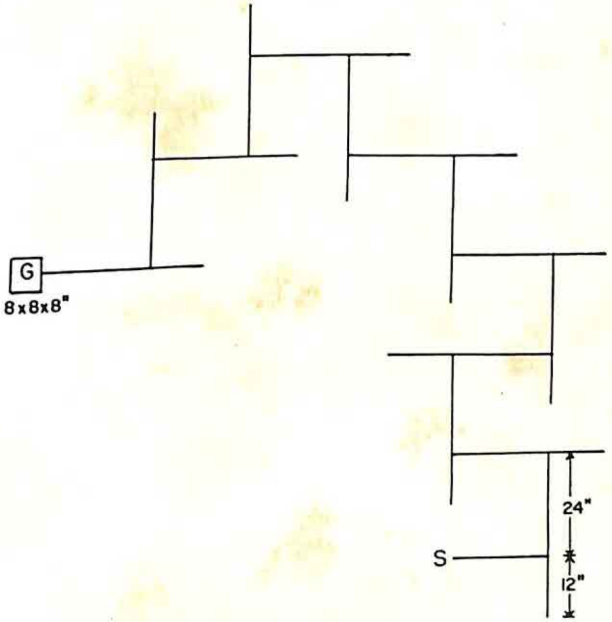

FIGURE 1
DIAGRAM OF EXPERIMENTAL MAZE

The *S*s were placed in groups on the basis of the number of trials necessary for each *S* to reach the initial criterion on the training maze.

Control Group I (N=10) was given sham radiation and was then retested on the training maze until reaching the new criterion of one or less errors on any one trial.

Experimental Group I (N=10) was exposed to 400 *r* of gamma radiation and retested on the training maze to the new criterion.

Control Group II (N=10) was also given sham radiation and was then tested on the experimental maze until reaching the criterion of one or less errors on any one trial.

Experimental Group II (N=10) was exposed to 400 *r* of gamma radiation and then tested on the experimental maze until they reached the new criterion.

b. Radiation. The Co^{60} facility used has been described by Auxier (2). The *S*s were irradiated 24 hours after reaching criterion but were not tested until 24 hours later, thus introducing a 48-hour retention period into the study. The container which held the *S* while being irradiated was constructed of perforated aluminum and was seven inches long and two inches in diameter. The *S*s in Experimental Groups I and II were exposed to 100 *r* of gamma radiation per minute for four minutes.

c. Experimental training. The *S*s in Control Group I and Experimental Group I were returned for testing on the training maze 48 hours after reaching criterion on the training maze used during the preliminary training which was 24 hours after irradiation of Experimental Group I. The retesting procedure was the same as that used during preliminary training.

The *S*s in Control Group II and Experimental Group II began training on the experimental maze 48 hours after reaching criterion on the training maze which was 24 hours after irradiation of Experimental Group II. The training procedure was the same on the experimental maze as it had been on the training maze.

All the *S*s reached criterion on the training maze in six trials or less. Even though the groups were matched on the basis of the number of trials to criterion, the total number of errors to criterion were computed and compared using Chi square. The Chi square was 0.476 which is not statistically significant. This enables us to conclude that the groups were matched as to learning ability. Time measures were kept as a possible index of postirradiation malaise.

As each *S* reached criterion on the training maze it was irradiation or sham irradiated 24 hours later. The day following irradiation the *S*s were watched closely as to food intake. All *S*s ate without any apparent reduction in quantity. At no time during the postirradiation phase did any *S*s indicate malaise as defined by reduction of food consumption.

C. RESULTS

1. *Postirradiation: Control Group I and Experimental Group I*

The *S*s in Control Group I and Experimental Group I were returned to the training maze for testing 24 hours after irradiation of the experimentals and were run until they reached a criterion of one or less errors on any one trial, which would occur with probability less than .01 if performance on the maze was attributable to chance factors. The best *S* reached criterion on the first trial after irradiation and the worst *S* took five trials. The number of errors made after irradiation was almost the same as before irradiation. Radiation, therefore, did not adversely affect the rate of learning in Experimental Group I when compared with that of Control Group I. An analysis of variance was used to test the number of trials necessary for each group to reach criterion. The *S*s in Control Group I and Experimental Group I required significantly fewer trials ($p < .001$) to master the post-irradiation test than did Control Group II and Experimental Group II. This was to be expected as they continued training on the same maze, while the other *S*s were transferred to a new maze. An .001 level indicated significant difference between the number of trials the various groups required to reach criterion on the experimental training. Scheffe's (19) method was used for determining the standard error of the means before comparing the groups. Experimental Group I made significantly fewer errors than Experimental Group II and Control Group I made fewer errors than Control Group II. As indicated earlier this is a function of the difficulty of the postirradiation tasks. Experimental Group I made more errors in reaching the postirradiation criterion than did Control Group I although their errors were not significantly different from their preliminary training performance.

Time measures have been used by some investigators as an index of malaise. There were no significant time differences between the last preliminary training trial and the first trial postirradiation.

2. *Postirradiation: Control Group II and Experimental Group II*

After irradiation the *S*s in these groups were trained on the experimental maze. A Chi square test was made on the total number of errors made per group. Experimental Group II made significantly more errors ($p <.01$) on the experimental maze than did Control Group II.

The postirradiation time and error scores for the first three trials were analyzed. These were the only trials on which data for all *S*s were available. The time differences between Control Group II and Experimental Group II for all three trials were found to be significant at the .01 level. Therefore *t* tests were run to determine which trials differed significantly. The time scores on Trial 1 were found to be significantly larger than those on either Trial 2 or Trial 3 ($p=.01$); however, the differences for running time on Trials 2 and 3 were not significantly different. The error scores yielded significant differences at the .05 level for differences between Control Group II and Experimental Group II.

In addition to analyzing the above, a subjective evaluation of the performance of the *S* was made for the second phase of the study. Control Group I and Experimental Group I did not alter their performance, but Control Group II and Experimental Group II slowed down on the first trial post-irradiation. The *S*s in Control Group II, after running into a few culs on the experimental maze, stopped at each choice point and made typical investigatory motions; i.e., sniffing, looking from side to side, etc. After making a few errors, the *S*s of Experimental Group II stopped completely at a choice point acting as they had on the first day on the training maze, except that they started moving spontaneously after traversing several sections of the maze. Control Group II performed as they had on the training maze, while Experimental Group II ran into culs, often partially running off the end. They appeared unaware of the change in the maze pattern.

Another aspect to be investigated was the consistency of errors. From the behavior observations it was assumed that the irradiated *S*s on the experimental maze might be more stereotyped in performance, thus making more consistent trial to trial errors. The number of errors per trial per cul were tabulated for Control Group II and Experimental Group II and the consistency of their responses correlated for all trials on which data for all *S*s were available. The rho's are given in Table 1. Although all rho's are significant in themselves, they do not differ significantly from each other.

TABLE 1
RANK ORDER CORRELATION—CUL ERRORS

Prelim. Tng. Trials	rho Cont. Gr. 2	rho Exp. Gr. 2
1-2	.75	.78
2-3	.87	.82
3-4		.77
4-5		.83

$p_{.01} = .80$

$p_{.05} = .66$

Control Gr. 2 and Experimental Gr. 2

Trial	rho
1	.83
2	.84

Another possibility is that each group made consistent errors from trial to trial, but the culs in which they made the errors were different. Post-irradiation Trials 1 and 2 for Control Group II and Experimental Group II were therefore correlated. As shown in Table 1 the inter-group performance correlates as highly as the intra-group performance.

The reliability of the mazes was calculated using odd-even trials, and the coefficient of reliability for the training maze was .95, for the experimental maze .94.

D. Discussion

The purpose of this investigation was to determine if exposure of an organism to sub-lethal ionizing radiation affected the organism's ability to reorganize a previously learned response series into a new response series. The results clearly indicated that radiation affects this reorganization ability as defined by errors.

Although nearly all investigations have indicated that irradiation does not affect the rate of learning, this variable was controlled for in the present study by using Control Group I and Experimental Group I for simple irradiation effects on rate of learning. The lack of any significant difference between the errors made by these groups postirradiation indicates that exposure to radiation at the dose level used does not cause performance decrements as defined by errors.

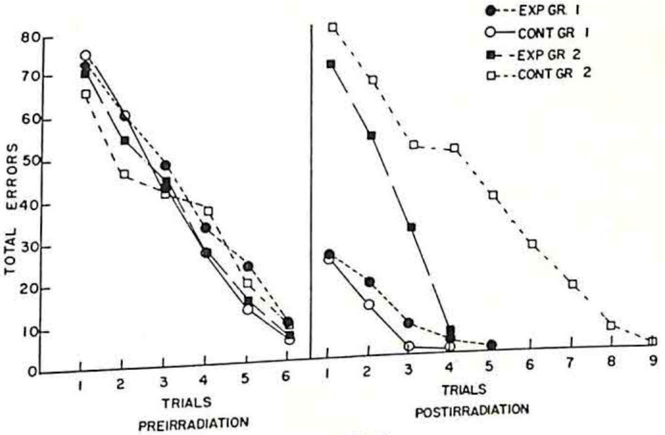

FIGURE 2

Error on Pre- and Postirradiation Trails

Testing only the number of trials necessary to learn the problem did not determine if the rate of learning was comparable. Figure 2 shows that the learning curves for the two groups were parallel, which would indicate their rate of learning did not differ. The tabulation of total errors again corroborates the lack of difference between these two groups in their postirradiation performance. It was therefore concluded that exposure to ionizing radiation at the dose level used has no deleterious effect on the retention of response patterns. Since there was no apparent decrease in food consumption after irradiation, a check of running time of the last preliminary training trial against the first postirradiation trial was made. Since the groups did not differ significantly in their running time between the pre- and postirradiation testing, one may therefore assume that malaise as indicated by an increase in running time, is apparently not a factor in this investigation. When Control Group II and Experimental Group II were run on the experimental maze after irradiation, there was a significant decrement in the performance of the experimentals. These groups also differed significantly from Control Group I and Experimental Group I, indicating that some of the differences are maze determined. This result was expected as it would, of necessity, take longer to learn a new task than to improve on a partially learned task.

The behavior of Control Group II and Experimental Group II on the experimental maze suggests the possibility that the experimental *S*s were making errors in different culs from the control *S*s. Rank order correlations were computed for cul errors and are shown in Table 1. The correlation is .83 for Trial 1 and .84 for Trial 2. This result indicates that there is no qualitative difference in learning between experimental and control *S*s on the experimental maze. The errors are apparently maze determined rather than group determined. That errors are maze determined is again supported by the intra-group correlations (see Table 1).

The contradictory results of this experiment in relation to the majority of other investigations in this area require considerable analysis to determine the possible factors operating. Results of this investigation suggest that the lack of positive results in most other investigations may be a funcion of the techniques used, which were essentially preirradiation training and testing for retention.

E. Summary and Conclusion

Forty female rats were trained to a criterion of three or fewer errors on an elevated T-maze reproducing the Tolman-Honzik maze pattern. After reaching criterion the *S*s were divided into two groups of 20 each. One half of each group was exposed to 400 *r* gamma radiation at a rate of 100 *r* per minute. One group continued training on the original training maze while the other group was trained on a new maze pattern, randomly determined. Both groups continued training until they reached a criterion of one or less errors on any one trial.

The results indicated that this dose rate of gamma radiation does not affect the retention of a task learned previous to radiation nor does it cause any decrement in postirradiation improvement of performance on the same task. Exposure to this dose, however, does cause a decrement in the capacity of *S*s to reorganize the preirradiation response pattern into a new response pattern postirradiation. The decrement is of temporary duration and of a quantitative rather than qualitative nature.

Similar to previous investigations, the running time was not significantly affected by exposure to this dose rate of irradiation, errors being the significant index of irradiation effect.

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PERCEPTUAL AUTISM IN CHILDREN: THE EFFECTS OF REWARD, PUNISHMENT, AND NEUTRAL CONDITIONS UPON PERCEPTUAL LEARNING*

The Menninger Foundation

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A. GENERAL INTRODUCTION

The purposes of the present studies were to explore the effects of monetary reward and punishment upon perceptual organization in children, and to investigate certain relationships between perceptual organization, rewards and punishments, and the quality of the interaction between child and experimenter.

There are many indications in psychoanalytic theory and developmental psychology that children are more likely to organize percepts in an autistic manner than are adults (4, 7). There is also ample basis in the literature (4, 7) for the assumption that changes in the quality of perceptual behavior with age exist, and that such changes indicate growing dominance of autism-free perceptual organization. By studying children at various chronological ages one can study changes in plasticity of perceptual organization and the gradual emergence or relative dominance of various perceptual mechanisms.

B. EXPERIMENT I

1. *Introduction*

We are using the term "autism" in a fairly general sense, and do not employ it in the traditional, clinical sense. Autism is here defined as "the movement of cognitive processes in the direction of need-satisfaction" (1, 3); a definition cast in terms of the "autism hypothesis." This definition was used by Solley and Sommer (6) in a series of studies exploring the "autism hypothesis" which showed that children between five and nine years of age perceived a reward-associated stimulus as "figure" over a "neutral" stimulus. These stimuli were the facial profiles used in the Schafer-Murphy (5) experiment with adults, and the test figure was a combination of the two pro-

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files (see Figure 1). The children also reported that the reward-associated profile looked "happier," "brighter," "nearer," and as having a darker contour. In these studies the children reported the "name" of the profile which they perceived in the test situation. It could be argued that the results of Solley and Sommer (6) were due to nothing more than verbal conditioning somewhat like the following paradigm. The *E* names each profile as it appears in the training phase. The *S* subvocally repeats the name immediately, without *E* being aware of it. The *E* tells *S* that he wins 15 cents for one profile (*S*'s verbal response is rewarded and increases in probability of occurrence) or tells him "nothing happens" for the alternative profile. As a consequence, in the test situation one verbal habit may be stronger than the other, and the name of one test figure is given with greater frequency than the name of the other.

To eliminate the possibility that only verbal conditioning occurs, a new procedure was used in the present study. The same training procedure was employed but in the test situation *S* indicated by pointing which face he saw. Since each profile appeared facing left or right equally often, no specific directional response could have been reinforced. We reasoned that if the same results are obtained in the present study as in the Solley and Sommer research (6) they could not be due to simple verbal conditioning.

It also seemed desirable not only to check the results of the "reward-neutral" condition, in which a rewarded and non-rewarded percept compete in a "figure-ground" test, but also to explore the effects of punishment (loss of money) in combination with reward and neutral conditions. Our reasons for this were as follows. It was possible that previous studies drew attention to the action-associated profile since in giving the reward action was associated with one profile and no action with the other. In one of the new conditions—punishment-neutral—we would have action associated with one profile and nothing with the other; but the action being associated would be one of mild punishment. If the children were operating "autistically," they would perceive the rewarded profile in the reward-neutral and in the reward-punishment conditions and the "neutral" profile in the punishment-neutral condition. This was the operational form of the "autism hypothesis." If the children were responding to the attention-getting quality of the experimental procedure, they would perceive the rewarded profile in the reward-neutral situation, the punished profile in the punishment-neutral condition, and neither profile more often than the other in the reward-punishment situation. This was the operational form of the "attention hypothesis."

Let us repeat that the only condition in the present experiment about which we could feel fairly confident was the reward-neutral situation, since it had been tested before (6). In that condition we hypothesized that the rewarded profile would stand out in the perceptual field. We also hypothesized that the rewarded profile would be judged to be "happier," "brighter," "nearer," and as having a darker contour. The hypotheses involving combinations of rewarded, punished, and "neutral" stimuli were made with less confidence.

2. *Method*

a. Subjects. Fifty-four children participated; 30 were between five and eight years of age and 24 were between nine and twelve years of age. Five of the younger and four of the older children were randomly assigned to each of the six experimental conditions (to be explained later). No restrictions were made as to sex.

b. Procedure

(1). *Reward versus neutral condition.* The *S* was instructed to look into a Dodge-type tachistoscope to see some pictures of two people which *E* would show one at a time and name "Clem" or "Jake." Preceding the training period the *S* was told that sometimes Clem would be looking to the right and sometimes he would be looking to the left, and that this would also be true for Jake (If *S* indicated that he did not understand this, *E* demonstrated using his own profile). The *S* was told that he would sometimes win, i.e., take nickels from a stack belonging to *E*, that sometimes nothing would happen, and that sometimes he might lose some of his nickels. The pictures were presented at ⅓ second exposure. Clem and Jake pictures were presented in a random order, each picture being presented 10 times (five times for each mirror image). These pictures are shown in Figure 1 looking in one direction.

Nine *S*s were allowed to take three nickels every time Clem appeared in the tachistoscope and nothing everytime Jake appeared. Nine other children won three nickels when Jake appeared and nothing when Clem appeared. During this procedure, each child won 30 nickels.[2]

Immediately following the training period, *E* told *S* that he was now going to show him the same pictures that he had just seen except that this time there would be a circle around the picture. The test picture is also shown in Figure 1, (half of the test pictures were mirror images of the one shown). The S was told to indicate by pointing which way the face was looking. The two test figures were shown at ⅓ second exposure in a random order for a total of 20 trials. The E recorded what S reported seeing on each presentation, as well as any spontaneous comments. After the test period was over, the test figure was exposed continuously and S was asked to describe everything he saw. As soon as S reported seeing both profiles, E asked the following questions. (For nine children the test picture had to be removed from the tachistoscope and both faces directly pointed out before both faces were seen.) The questions were asked as follows: (*a*) "Which of the two faces looks the happiest?"; (*b*) "Which of the two faces looks like it is nearer to you?"; (*c*) "Which of the two faces looks like it has the most light shining on it?"; and (*d*) "Which of the two faces looks like it has the darkest line drawn around it?" The E recorded the answers and all spontaneous comments.

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[2] It was agreed that at the sign of major discomfort from any child, the training period would be cut short and the test series would follow immediately. This situation arose with five children—all of whom showed distress in the punishment-neutral condition.

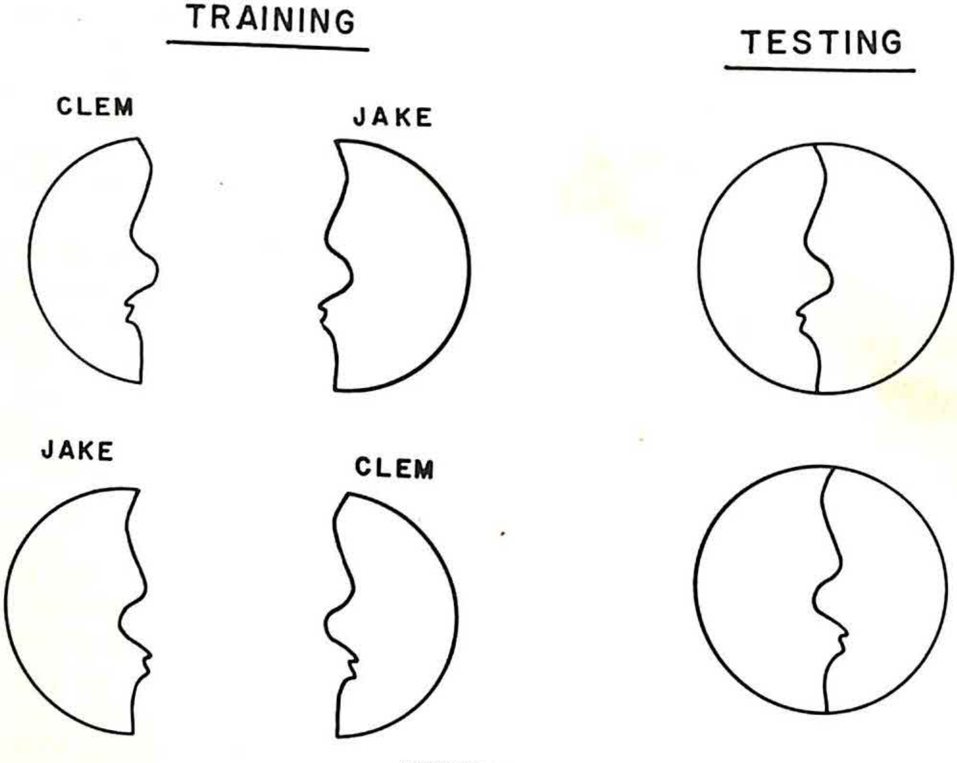

FIGURE 1
PROFILE DRAWINGS USED IN TRAINING AND TESTING

(2). *Reward versus punishment condition.* The same procedure was followed except that *S* was given 30 nickels to begin with and he won three nickels when one face appeared and lost three nickels when the alternative appeared. The two profiles were counterbalanced with respect to reward and punishment.

(3). *Punishment versus neutral condition.* The same procedure was used except that *S* was given 30 nickels to begin with and he lost three nickels when one face appeared and nothing happened when the other appeared. In this manner he lost all his nickels. The punishment and neutral operations were counterbalanced for the two faces.

3. *Results*

The results of the initial test-response and the answers to the questions for the reward-neutral, reward-punishment, and punishment-neutral conditions are summarized in Tables 1, 2, and 3.

Table 1 shows that in the reward-neutral condition the rewarded profile was reported as "figure" in the initial test-trial (significant at the .01 level of confidence). The rewarded profile was also reported as "happiest," "brightest," and "nearest"—each of these measures being significant at the .01 level of confidence. It was also reported as having the "darkest line" around it at the .05 level of confidence. These data correspond quite well with the data collected in earlier experiments (6) in which a "naming" response was used instead of the "pointing" response used in the present studies. There were no significant differences between age levels.

Table 2 shows that in the reward-punishment situation the majority of the children reported the rewarded profile as "figure" in the initial test trial but this result was not statistically significant. The children also reported the rewarded profile as "happiest," (significant at the .01 level of confidence). The other questions showed no significant results except that "Clem," independent of rewards and punishments, was described as having a darker line around it—a definite facial preference. Again, there are no significant differences between age levels.

Table 3 shows that there may be a significant difference between age levels in the effects under the punishment-neutral condition. That is, the younger children reported the "neutral" face as "figure," but the older children reported the punished face as "figure" ($p = .09$). This is confirmed by the analysis of the total test scores. The neutral face was described by both young and older children as "happiest," and the punished face was described as being "brightest," each of these effects being significant at the .05 level of confidence.

TABLE 1
RESULTS OF REWARD-NEUTRAL CONDITION[a]

Measure	Age	Profile reported	
		Rewarded	Neutral
First response	5-8	9	1
	9-12	6	2
	Pooled	15	3
Happiest	5-8	10	0
	9-12	7	1
	Pooled	17	1
Closest	5-8	9	1
	9-12	5	1
	Pooled	14	2
Brightest	5-8	8	2
	9-12	7	0
	Pooled	15	2
Darkest line	5-8	8	2
	9-12	5	1
	Pooled	13	3

[a] *S*s who reported "neither" or "both" were eliminated.

TABLE 2
RESULTS OF REWARD-PUNISHMENT CONDITION[a]

Measure	Age	Profile reported	
		Rewarded	Punished
First response	5-8	7	3
	9-12	4	4
	Pooled	11	7
Happiest	5-8	7	3
	9-12	8	0
	Pooled	15	3
Closest	5-8	5	5
	9-12	5	3
	Pooled	10	8
Brightest	5-8	5	5
	9-12	4	2
	Pooled	9	7
Darkest line	5-8	5	4
	9-12	2	6
	Pooled	7	10

[a] *S*s who reported "neither" or "both" were eliminated.

TABLE 3
RESULTS OF EXPERIMENTS I AND II IN PUNISHMENT-NEUTRAL CONDITION[a]

Measure	Age	Exp. I Profile reported		Exp. II Profile reported		Pooled	
		Punished	Neutral	Punished	Neutral	P	N
First response	5-8	3	7	1	5	4	12
	9-12	7	1	3	1	10	2
	Pooled	10	8	4	6	14	14
Happiest	5-8	0	10	2	4	2	14
	9-12	2	6	0	4	2	10
	Pooled	2	16	2	8	4	24
Closest	5-8	8	2	1	6	9	8
	9-12	5	3	2	1	7	4
	Pooled	13	5	3	7	16	12
Brightest	5-8	7	2	6	0	13	2
	9-12	6	2	2	1	8	3
	Pooled	13	4	8	1	21	5
Darkest line	5-8	6	4	3	4	9	8
	9-12	5	2	2	2	7	4
	Pooled	11	6	5	6	16	12

[a] *Ss* who reported "neither" or "both" were eliminated.

In addition to these analyses, the overall difference scores were computed and analyzed. In each condition each *S* had two scores, e.g., in the reward-neutral condition a child would indicate seeing the rewarded profile on some of the test trials and the neutral profile on the remaining trials. A difference score was computed by subtracting the number of times the child reported seeing the neutral profile from the number of times he reported seeing the rewarded profile. To test the autism hypothesis, the number of times the neutral face was reported was subtracted from the number of times the rewarded face was reported; the number of times the punished face was reported was subtracted from the number of times the rewarded face was reported; and the number of times the neutral face was reported was subtracted from the number of times the punished face was reported in the reward-neutral, reward-punishment, and the punishment-neutral conditions respectively. To test the "attention hypothesis," the number of times the neutral face was reported was subtracted from the number of times the rewarded face was reported in the reward-neutral condition, and the number of times the neutral face was reported was subtracted from the number of times the punished face was reported in the punishment-neutral condition. Table 4 shows the number of *S*s who yielded total difference scores supporting or not supporting the "autism hypothesis." It also shows the number of *S*s whose behavior supported or did not support the "attention-hypothesis."

TABLE 4
SUMMARY OF NUMBER OF SUBJECTS, POOLED OVER CONDITIONS PRO AND CON AUTISM AND ATTENTION HYPOTHESES IN EXPERIMENT I

Score		Autism Test (R-N, R-P, N-P) 5-8	9-12	Pooled	Attention Test (R-N, P-N) 5-8	9-12	Pooled
First response	Pro	26*	11	37*	12	13*	25*
	Con	7	13	20	8	3	11
Total difference	Pro	21*	14	35*	11	11	22
	Con	8	8	16	9	4	13

* Significant at .05 level (sign test).

Table 4 shows that the "autism hypothesis" is favored by the data from both younger and older children, but that only the data from the older children support the attention hypothesis. We shall return to these points in some detail in the discussion section.

Not all of the preceding analyses reveal directly developmental trends. These trends are graphically shown in Figure 2. Figure 2 shows that "autism" as a major factor in "figure-ground" organization seems to diminish with age though "autism" still exists to a limited extent in adults. Figure 2 also shows that stimuli associated with punishment tend to acquire an attention cathexis with age.[3] We shall explore these results in the discussion section.

4. *Discussion*

In discussing the overall results of this study, let us first consider the reward-neutral condition and its results. The data from this condition, in which a simple pointing response indicated which face was seen, confirm the results obtained in earlier studies (6) in which there was a possibility of verbal conditioning. Since, in the training period, each face appeared equally often looking to the left and to the right, it is highly improbable that any simple response carry over from the training period to the test period could "explain" our results. We gather from this further confirmation of the earlier results that we are dealing with a genuine perceptual shift rather than the establishment of a simple response set.

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[3] The authors wish to thank Drs. Samuel J. Messick and Douglas N. Jackson for the permission to use their data on adults between 17 and 21 years of age which was collected using the same paradigm as the present study, the original idea for the design being Dr. Messick's.

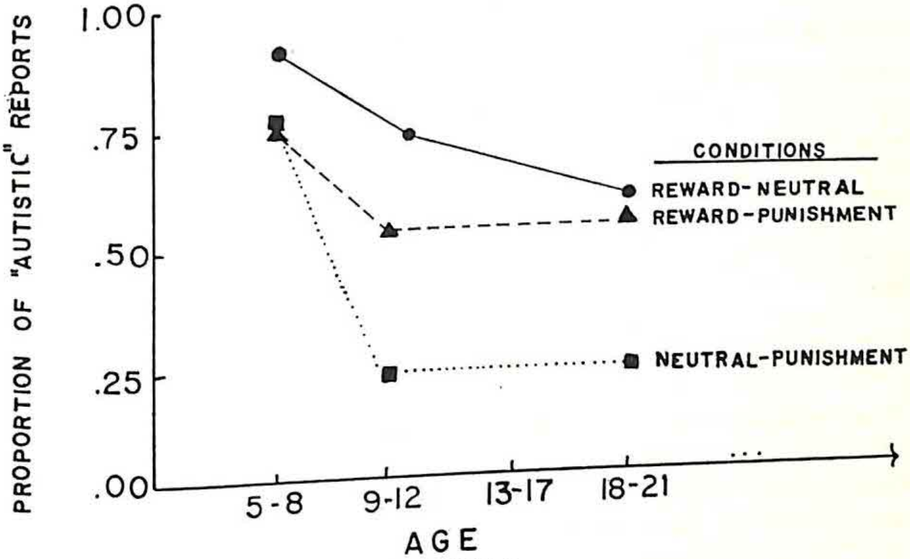

FIGURE 2
PROPORTION OF *S*s ORGANIZING THE AMBIGUOUS TEST FIGURE IN AN "AUTISTIC" MANNER AS FUNCTION OF AGE

The tests of the more general hypotheses, that of "autism" and that of "attention," yielded some surprising results. We had originally thought of these two modes of organizing perception as in opposition to one another. Our data indicate that both mechanisms operate, but that one mechanism may be dominant over the other at various stages of development. Generally it appears that young children organize the perceptual field so that rewarded percepts stand out over either neutral or punished aspects of the field and that neutral percepts stand out over punished aspects. Our data lead us to infer that as children grow and mature, rewarded percepts may still dominate neutral or punished aspects of the perceptual field though perhaps less so than in younger children. As youngsters mature they develop means and skills for dealing effectively with punishment. It appears that success in dealing with such mild punishments as loss of money depends upon being alert to punished aspects of the stimulus field. The punished percept seems to attract attention. We shall not go into any theory of the effects of punishment on perception at this time but wish to point out that our interpretation depends upon *how* the punishment is associated with a percept (2).

In addition to the specific results and hypotheses studied, we made many incidental observations that seem important in formulating further hypotheses. There were some striking individual differences in the reward-neutral and reward-punishment conditions, but in the punishment-neutral condition marked individual differences consistently appeared. For example, children who spontaneously chatted with the adult bringing them to the experimental setting almost always reported the punished percept when assigned to the punishment-neutral condition, whereas quiet children frequently reported the neutral aspect. Also, the children who were "active" during the course of the experiment (who asked questions about how the tachistoscope worked, about other children, or about the experimenter, etc.), often indicated the punished aspect as "figure" whereas children who "passively" submitted to the experiment reported seeing the neutral aspect as "figure." From such observations we formulated the hypothesis that the type of "punishment" (losing money) used in the present study might have served as a "reward" for children who enjoy social interaction with adults. Several such children looked at the experimenter, smiled, and laughed while giving up their nickels. An alternative hypothesis is that these children were avoiding punishment and attempted to control possible anxiety arousal by restructuring the meaning of the situation. By directing their attention to the apparatus or the experimenter, they were in effect reducing the "intensity" of the punishment, a factor which we are beginning to believe plays a major role in determining the fate of a percept associated with punishment.

C. EXPERIMENT II

1. *Introduction and Procedure*

The hypothesis that children who enjoy interaction with the experimenter direct their attention to the punished profile in the punishment-neutral condition seemed worthy of further investigation. More generally, we had become aware of individual differences in Experiment I, and decided to attempt a more systematic analysis of such differences in children. As a start, we made further analyses of the data from Experiment I. We correlated the number of "autistic" responses given in the first 10 trials with the number given in the second 10 trials of the ambiguous test series. This was done to check on the reliability or consistency of individual differences in the ambiguous figure-ground test trials. These product-moment correlations were .533, .541, and .595 for the reward-neutral, reward-punishment, and punishment-neutral conditions respectively. Each of these split-half correlations was significant at the .05 level of confidence. Since the data from the trials with the ambiguous figure-ground profiles reliably reflected individual differences in children, we decided to proceed.

The punishment-neutral condition, described in Experiment I, was repeated with the exceptions that only one test trial was given and the direct questions such as which face was "happier," were reversed, e.g., *E* asked *S* which face was "sadder." Twelve children were brought to the experiment, eight between five and eight years of age and four between nine and 12 years inclusive. One of the younger children was not included in the final study since he "knew" too much about the experiment, leaving 11 children as our sample. The children were picked up at their homes, in groups of two, by the first author and were taken to the experimental setting by car. This *E* recorded (*a*) where the child sat in the car, (*b*) whether or not the child spontaneously chatted with him, (*c*) whether the child seemed "friendly" or not, and (*d*) whether or not the child appeared "anxious."

The second author observed the first *E* and each child, through a one-way vision mirror, throughout the experiment. No child knew that he was being observed. This *E* judged each child on several six-point scales. These scales were (*a*) interest shown in apparatus, room, and test materials, (*b*) interest in the money, (*c*) general level of involvement with the first *E*, (*d*) how much attention the child paid to the experiment, (*e*) amount of extraneous chatter, (*f*) degree of involvement in total situation, (*g*) freedom in expressing affect, and (*h*) overt signs of anxiety or tension such as gum chewing, scratching, shifting. The second *E* also recorded her overall impressions of the child, when she felt something essential was missing from the rating scale data. Neither *E* knew what the other *E* had recorded until all the data had been collected and independently summarized. Nor did the observing *E* have any knowledge of the perceptual behavior of the children.

2. *Results*

As shown in Table 3, six of the seven younger children perceived the neutral face in the test trial whereas only one of the four older children saw the neutral face as figure. These data correspond closely with the data from Experiment I which are also shown in Table 3.

The two independent estimates of "anxiety"—one based on behavior in the car and one based on behavior in the experimental setting—showed a surprising amount of agreement in that the *E*s agreed on the classification of nine of the 11 children and disagreed on only two cases. Unfortunately, "anxiety" and "non-anxiety" did not correlate with which face was perceived in the test figure.

The casual observation, in Experiment I, that children who spontaneously chatted with the adult bringing them to the experiment reported the punished face as figure whereas those children who were quiet in the car reported seeing the neutral face was also checked. Five children in this study spontaneously chatted with the driver of the car (the first *E*) and six were quiet. All those who were quiet in the car reported seeing the neutral face in the ambiguous figure whereas only one of the five who chatted with the first *E* reported seeing the neutral face as figure. Four of the "talkers" reported seeing the punished face in the test trial. This result confirmed our hypothesis, formulated on the basis of unrecorded, casual observations made in Experiment I. We further learned that of those who talked to *E* in the car three were in the older group and only one was in the younger group. The younger children tended to sit in the back seat of the car and, with one exception, they did not talk freely with the driver. It appears that the older children—between nine and 12 years of age—tended to initiate social interaction with *E*. In short, the older children were more motivated by social needs to interact with *E* than were the younger ones.

The judgments on the scales and the other behaviors in the car did not correlate with which face was perceived in the ambiguous figure. However, the additional comments recorded by the second *E* did correlate with the organization of the test figure. No overall impressions were recorded for two of the 11 *S*s, leaving nine *S*s for this analysis. Among those who perceived the punished figure in the test trial, such descriptions as "hates to abandon money but does so with a smile" were recorded. Among those who perceived the neutral profile, such comments as "forgets names, is embarrassed" or "in a fog about losing money," were recorded. These comments are summarized in Table 5.

3. *Discussion*

The results of Experiment II confirmed our previous impression that the loss of nickels in the punishment-neutral condition was not nearly so important to the child as the social interaction with the *E* and the value the child put on such interaction. The loss of nickels was an opportunity for interacting with the adult and served as a positive reinforcement for some *S*s. This, in turn, is correlated with age of the children. The younger children were more isolated physically (sitting in the back of the car) and psychologically (no talking to driver of car) from *E* than were the older children. As children mature, they learn to place positive value on almost any form of social interaction even if it is mildly punishing. A mildly punishing interaction is preferable to no interaction, the equivalent of being ignored.

TABLE 5
SUMMARY OF "EXTRA" COMMENTS RECORDED ON CHILDREN IN EXPERIMENT II

Face perceived on test trial	Age range	S	Comments as recorded
Neutral	5-8	2	Doubtful. Timid at first. Somewhat leary, ill at ease, wondering what this is all about.
		3	Is in a fog about why lose money. Becomes gradually more puzzled about loss of money. Keeps hand on money even after he lost it.
		4	(No comments recorded)
		5	(No comments recorded)
		8	Holds finger pointing until Charlie notices. Has to have instructions explained. Almost cries at end. Wants to head back to basement (where study was held) at end.
		10	Rather upset, anxious, and feels inadequate in situation. Is *not* enjoying this.
	9-12	6	Smiles each time he moves money. Painfully shy.
Punished	5-8	1	Begins to wonder what's wrong but remains involved. Happy, interested, involved. Hates to abandon money but does so with a smile. Wonders what he does wrong. (Says) "I don't know who they are."
	9-12	7	All American boy. Crisp, clean, efficient performer, at ease.
		9	Frequently smiles up at Charlie, broad grin has a forced quality. Does not like to lose but takes it with a grin. Casts one annoyed look at Charlie when latter not looking at him. Smile gradually fades away.
		11	Tries as much as possible to avoid close contact with *E*. Phony "who cares" mood. Shrugs shoulders when losing money to indicate it doesn't matter to him. Creates tense, distant mood.

D. GENERAL DISCUSSION

A fairly consistent picture appears when one surveys the data from both experiments simultaneously. A long-range, developmental picture of perceptual learning emerges, in which the interaction of affect-arousal, affect-control, and perceptual learning stands out. Although we are fully aware that our data lend themselves to a number of interpretations we choose to summarize our conclusions in an unequivocal way. Our purpose in so doing is to present a synthesis which is as internally consistent as possible.

It appears that young children between five and eight years of age *display* more affect than do older children between nine and 12 years of age. That is, the aroused affect appears more directly, with less modulation by defenses, than it does in older subjects. However, we doubt seriously that the total amount of aroused affect is different in the two age groups. The older children have developed socially acceptable means for controlling aroused affect. In short, the *primary* difference between older children and younger children lies in their abilities to cope with affect arousal in the experimental situation.

In line with this point, the most striking effect that we observed was the "scotomization" of the punished profile by some of the younger children in the punishment-neutral condition. There were five children in all who displayed major discomfort during the training phase. All of these were younger children. All of them reacted alike to the perceptual test, all seeing the neutral face in the ⅓ second test trial. When the ambiguous test figure was exposed fully and continuously, all continued denying the presence of the punished face saying that there was only one face present and that that one was the neutral face. It was necessary in each case to take the test figure out of the tachistoscope and cover the neutral face before they could see the punished face. A high degree of displayed affect, less mature methods of controlling the aroused affect, and perceptual autism operate jointly in the younger children.

The older children presented a different picture. They, too, were bothered by the loss of nickels—and they were the ones who made nasty faces at the experimenter while his back was turned. What was strikingly different was the affect-controlling behavior. That is, the older children would smile or grin while giving up their money (the old adage of "grin and bear it" was very evident). They would more often try to "control" the experimenter by asking questions about the apparatus, about the experiment, or about the experimenter himself. The older children, in short, were reducing the final impact of the unpleasant affect aroused by the situation by means of learned, socially approved affect-control behavior. This "control" extended itself into the perceptual learning situation.

The changes in modes of organizing the perceptual field from "autistic" to "attention-cathecting" are not products of age alone. The picture is much more dynamic than that. As the child matures, he changes from one complex function to another, and never develops smoothly along a continuous line. His capacities for displaying affect, for controlling affect, and his needs such as for food, warmth, love, social approval, all change dramatically within the first 12 years of life. And all of these are vital parameters influencing the rate and direction of perceptual learning.

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A COMPARATIVE STUDY OF THE VERBAL AND PERFORMANCE ABILITY OF MONOLINGUAL AND BILINGUAL NATIVE BORN JEWISH PRESCHOOL CHILDREN OF TRADITIONAL PARENTAGE*

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A. PROBLEM

From the many studies made of the intelligence test scores of Jewish students, it appears that Jewish elementary school, high school, and college students have a higher verbal than performance ability (13, 16, 17, 32). The verbal *IQ* of the "average" American, however, is equal to the performance *IQ* (31, 32). This evidence of superior verbal ability indicates a different constellation of intellectual abilities among Jews as compared with the general population. Several significant questions arise concerning this deviation among Jewish students from the pattern of "average" Americans, such as: When does this difference begin? Do these differences result from school experiences? Do these differences also exist at the preschool level?

Among the interrelated factors which may influence the psychometric pattern of the Jewish preschool child are:

(*a*) Bilingualism. At the preschool level performance *IQ*s are usually higher than verbal *IQ*s (3). Is this finding also true for most bilingual Jewish preschool children? Further, at the preschool level, the bilingual child's verbal ability is below the average of monolingual children (3). Is this also true for Jewish preschool children?

(*b*) Sex differences. What role do sex differences play in the intelligence of Jewish preschool children? Since the Jewish home exerts stronger cultural pressure for achievement upon Jewish boys than upon girls (15) does this bring about a higher score for the Jewish boy? Since more boys continue with their education than girls, it is most important in comparing differences between male and female Jewish children of traditional background, to do so at the preschool level to avoid the effects of the selective factors which enter later.

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[1] The writer wishes to express his appreciation to Mrs. Anne Rosenbaum who tabulated most of the statistical data.

B. Method

1. *Definitions of Terms*

Bilingualism. For the purposes of this study, a child was considered bilingual whenever the parent indicated that either one or more foreign languages, or both a foreign language and English were spoken in the home. Bilingualism was the only factor in which the two groups differed. Both the monolingual and bilingual groups were bicultural, the two cultures being American and the traditional Jewish culture. An attempt was thus made to avoid the pitfall stressed by Soffietti (27) of confusing bilingualism and biculturalism.

Verbal test. A verbal test is a test requiring the understanding and use of words.

Performance test. A performance test is one which requires the manipulation of objects rather than an oral response.

Both verbal and performance tests used in this study required understanding of English, inasmuch as all tests necessitated verbal instructions. It is to be noted that the psychological processes employed in responding either to the verbal or performance tests, are not mutually exclusive. In performance tests, too, we quite frequently find a sort of talking to one's self or verbalization. The question arises as to whether bilinguals can verbalize their thoughts (in any language) as well as do monolinguals? One must inquire, further, whether such a handicap, i.e., to think well using verbal symbols, is also reflected on the performance tests?

No investigation was made of the extent of bilingualism in the home; nor was it possible to study the methods by which a child was called upon to adjust to the two languages. We, further, have no inkling as to whether each parent spoke a different language to the child, or whether the parents spoke a foreign language exclusively, necessitating the learning of English solely from associations made outside of the home. Neither do we know the extent of the child's attainment in the foreign language or languages, or the extent to which the foreign language was spoken socially. We, furthermore, do not know whether bilingualism was due to an effort on the part of the parents to preserve the foreign language for cultural reasons, or was due to lack of familiarity with English. It is to be noted, however, that all the bilingual children spoke English very well, and they used English in their day to day contact with their playmates. It was felt by the examiners that the inability of some of the bilingual children to solve certain problems was not, as far as they could determine, due to the lack of language facility.

Another factor which becomes an artifact in a study such as this, is the tendency among preschool children to give a better account of themselves with performance rather than verbal materials. In this connection, the study made by McHugh (21) is pertinent. He gave the 1937 Binet, Form *M* or *L*, to a group of children who were about to enter the kindergarten. The alternate form of the test was given to these children two months later, after they had attended and adjusted to kindergarten. There was gain of 6.07 *IQ* points. Furthermore, there was an 11.2 per cent improvement in those tests which could not be passed without oral speech, as compared to the 4.7 per cent improvement in items which could be passed successfully without the use of oral speech.

2. *Criteria Used in the Selection of Tests*

The following criteria were used in the selection of tests:

1. The tests selected should be of an intrinsic interest to the preschool child so as to obtain his maximum cooperation.

2. The tests selected should be measures of as many different aspects of both verbal and performance abilities as possible within the experimental situation.

3. Research data other than that given by the authors of the test should be available to enable us to evaluate the validity of the observed differences, if any. Since relationships of abilities studied may differ at various age levels, these studies, whenever possible, should refer to findings with preschool children.

These precautions in the choice of tests were necessary in order to avoid mistaking the artifacts of the tests for the properties of our population.

The following tests were selected: Revised Stanford Binet, Form *L* (28), Wechsler Intelligence Scale for Children (31), Raven Coloured Matrices (24), and Goodenough Draw-A-Man (8).

3. *Previous Research*

a. Sex differences. The writer reviewed elsewhere (15) the few studies available regarding sex differences in intelligence of Jewish preschool children. The writer's study has shown that while Jewish preschool boys of traditional background are brighter than girls, this difference is statistically not significant.

b. Bilingualism. We do not have any studies in the exact area of this investigation. We do have some related studies. Darcy (7) found that bilingualism affected the verbal intelligence scores of Italian preschool children. On the other hand, Pintner and Arsenian (23) established that bilingualism does not affect the verbal intelligence of Jewish children ages nine to 14. Arsenian (3), after reviewing over 100 investigations of bilingualism in this country and abroad, found that "bilingualism neither retards nor accelerates mental development." He further found that this was evident when non-verbal tests of intelligence were used. However, the bilingual children did poorly as compared with monolingual children on verbal tests.

c. Verbal and performance ability. The writer has not been able to find any published study on the preschool level in this area. Brown (5) found Jewish children to be superior on tests based upon general information and verbal comprehension. This writer found, on the college level, that the Yeshiva college student's verbal *WAIS IQ* was 125.59 and his performance *WAIS IQ* was 105.30. This difference of 20.29 *IQ* points was statistically significant at the one per cent level of confidence (16). A study now in progress of verbal and performance ability of Jewish, Irish, and Italian boys attending parochial schools who were individually matched for total *WISC IQ,* indicated that the Jewish children had the highest verbal *WISC IQ,* and the Italian children the highest performance *WISC IQ*s. These differences were statistically significant (17).

4. *Tests*

a. Terman-Merrill Revision of the Stanford Binet Scale (28). The Terman-Merrill Revision of the Stanford Binet Intelligence Scale was standardized on 3184 native born white subjects ranging from two to 18 years of age. Reliability coefficients range from .90 to .98 (28). Innumerable research studies have confirmed the fact that this test is both reliable and valid. The tests at the preschool age require the solution of both verbal and performance tasks. McNemar (22) arranged the non-verbal items of Terman-Merrill Form *L* into a scale which he found to correlate .53, .67, and .77 with *MA*s at 5, 5½, and 6 years. One must remember, of course, that these correlations are spuriously high because the non-verbal items are included in the total scale. This scale has a reliability averaging about .65. We omitted Item *M,* IV, alt. and pro-rated the other items accordingly. While this non-verbal scale is not sufficiently reliable for individual diagnosis, it appears adequate for group comparison and as an indicator of trends. It is thus used in our study.

b. Raven Coloured Matrices (24). The Raven Coloured Matrices was standardized upon a sample of 608 English children ages 5 to 11½. It consists of abstract designs from which a part has been removed. The child selects the proper insert. The test measures "accuracy of discrimination" and the eduction of relations. We do not have adequate preschool norms for this test. The norms available are either based upon an English sample, or the method of administration (10) of the test upon which the new norms are based departed so radically from standard administration that comparisons are not possible. This test was not used, therefore, in comparing verbal vs performance ability.

c. Goodenough Draw-A-Man Test (8). In this test, the child is instructed to "make a picture of a man: make the very best picture you can." Scoring is in terms of how many important parts of the man, such as eyes, mouth, hands, etc., are included. This test was standardized on children between the ages of four and 10. This drawing test (12) measures "ability to form concepts based upon observation."

This is an old intelligence scale and has been used for many years as an independent test of intelligence. McCarthy (19) made a study of the reliability of the Goodenough Draw-A-Man Test. She found, on the basis of a study of 386 children, that the split-half reliability of the test was .89. Scorer reliability, when a test was scored by two different examiners, was .90 and by the same examiner .94. Ansbacher (2) found in a study of 100 fourth grade children that the test correlated very highly with tests of reasoning, spatial aptitude, and perceptual accuracy. McHugh (20) found in a study of 90 normal kindergarten children that the Revised Stanford Binet correlated .45 with the Goodenough. He felt that the r was depressed because two different forms of the 1937 revision of the Binet were administered.

Goodenough (9) administered the Goodenough Draw-A-Man test to 2,457 public school children, almost all of whom were American born. She found that the Jewish children (N of 55) had a Mdn *IQ* of 106.3, mean *IQ* 106.1, and *SD* of 16.2. This was the highest among the various racial and national groups examined.

d. Wechsler Intelligence Scale for Children. As is noted from the discussion of the previous tests, they have been standardized on different populations, and, therefore, the results obtained, when comparing functioning on these scales, may be criticized as due to the artifacts or deficiencies of measuring instruments, rather than due to intellectual functioning in the subjects studied. It was, therefore, necessary to select a test having both performance and verbal material which has been standardized on the same population. The Wechsler Intelligence Scale for Children *WISC* (31) was standardized on 2200 children and its effective range is for children between the ages of five to 15 years. It consists of six verbal tests: Information, Comprehension, Arithmetic, Similarities, Vocabulary, and Digit Span; and six performance tests: Picture Completion, Picture Arrangement, Block Designs, Object Assembly, Coding, and Mazes. Digit Span and Mazes are supplementary tests and, therefore, they were not considered in the computation of the *IQ*. The full scale verbal and performance *IQ*s secured express the position of a child within his own group.

There are conflicting research findings as to the relationship existing at the preschool level between the verbal and performance *IQ*s of the *WISC*.

According to Seashore (25) who analyzed all the *WISC* standardization data, there are no important age differences between the verbal and performance scores. Furthermore, outside of children with professional and semiprofessional backgrounds, there is no difference in either verbal or performance *IQ*s. The writer calculated the *IQ*s of preschool standardization group from data given by Seashore *et al.* (26). He found the mean verbal *IQ* of the boys (N200) to be 100.1, and of the girls (N200) to be 100.2. The corresponding mean performance *IQ* for the boys was 98.8, and for the girls 101.2. For the group as a whole (N400), the mean verbal *IQ* was 100.1 and the performance *IQ* 100.

Krugman *et al.* (14), on the other hand, did find such differences. Their study, based upon the analysis of the scores of 38 children aged six (the entire group consisted of 332 children) indicated that the Binet *IQ* was (111.87, *SD* 14.30) much higher than the *WISC* total *IQ* (101.87, *SD* 13.55) and that the *WISC* verbal *IQ* (103.97, *SD* 15.20) was much higher than the *WISC* performance *IQ* (97.97, *SD* 14.00).

These findings are partially confirmed in a study of 46 five-year-old children (29) of above average intelligence. The *WISC* full scale *IQ* (107.56) was lower than the Stanford Binet *IQ* (124.1). However, the *WISC* verbal *IQ* (103.39) was lower than the *WISC* performance *IQ* (111.07).

Similarly Cohen and Collier (6) reported that their study of 53 children aged 6 to 8 years has indicated the Binet *IQ* (104.8, *SD* 15.07) to be higher than the *WISC* full scale *IQ* (99.8, *SD* 14.26); the *WISC* verbal *IQ* (98.5, *SD* 14.48) to be lower than the *WISC* performance *IQ* (101.1, *SD* 14.51).

5. *Subjects*

In our selection of subjects we tried to control as many variables as possible so as to delimit the study to the factors studied. We attempted to select an equal number of children of both sexes and of monolinguals and bilinguals.

The subjects were all normal native born children coming from traditional

Jewish homes. They were selected from applicants for admission to four Hebraic Yeshivas[2] and may be considered representative of the children who apply for admission to the kindergarten or first grade of these schools. The tests were administered as part of the routine admission requirements. The children did not have any previous school experience.

6. *Examiners*

The examiners were paid graduate assistants who had a year's training in the use of these tests and extensive experience in testing preschool children. All the examinations were carried on under the immediate supervision of the writer and the scoring was checked by him. We had four examiners, one of them a woman. There were no consistent intraexaminer differences in *IQ* ratings secured. At all times the examiners were aware of the need for maximum motivation on the part of the subjects.

7. *Testing Procedure*

The order of administration of the tests varied. The Binet was administered first in half of the cases, and the *WISC* first in the other half. The verbal and performance scales of the *WISC* were also administered in counterbalanced order. These were followed by the other tests which were administered in random order. This testing procedure attempted to randomize situational factors such as fatigue, rest periods, and shifts in children's moods due to prolonged testing. There were, naturally, in view of the immaturity of the children, many intermissions between tests. Not more than one week, however, elapsed for the completion of a battery. Occasionally, certain children were not able to complete the testing schedule even at this relaxed pace. Some of these were unable to return to the clinic. This accounts for the fact that out of a sample of 238 children, only 117 (or 49.16 per cent) had records adequate for the study. This also explains the unequal number of tests for some children in the sample. What influence, if any, this elimination of 50.84 per cent of the original sample had on our findings is not known.

C. RESULTS

1. *Age*

The mean age of the group was 66.10 months with an *SD* of 4.55. Age range was from 5 to 6.

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[2] The Hebraic Yeshiva offers a broad program of studies in Bible and Talmud. The language of instruction is Hebrew (1).

2. *Socio-Economic Background*

Since we did not have a stratified sample, a question arises as to whether the socio-economic background of members of the group had, in any way, affected their intelligence. Furthermore, since the tendency of the traditional Jewish family to give a Jewish education to boys, rather to girls, is known, this selective bias may have existed in our sample which might have attracted girls from a somewhat higher socio-economic level than the boys.

Table 1 shows the mean Stanford Binet *IQ* and *WISC* performance *IQ*s of the boys and girls according to father's occupation (30). Note that only a chance relationship exists between socio-economic status and either verbal or performance intelligence for either the boys or the girls of our sample. While such a relationship may exist for the higher grades of day schools, it apparently does not hold true for the kindergarten and first grade applicants.

It may appear surprising to find that for our group the socio-economic level has no relationship to *IQ*. This is contrary to the findings of many previous studies 28, 31). This may either be due to (*a*) the fact that the Jewish traditional home has approximately the same cultural status at all socio-economic levels or (*b*) that the families sending their children to the Hebraic Yeshivas have the same cultural traditions and the socio-economic background is a mere artifact in their case.

We may, nevertheless, surmise that apparently, in the Jewish traditional homes studied, the important factors determining to a great extent the child's personality and intellectual traits, are not dependent on socio-economic factors. It further appears that the interest and concern of a parent with a child's progress, knowledge of children's schoolmates, attention to religious upbringing are related to the general traditional Jewish attitudes and have little relation to family income. The Jewish children of traditional background usually have a warm positive family atmosphere. Interaction between parent and child is encouraged. The children are expected to participate actively in Jewish religious observance.

Studies made with other groups indicate that it is parental attitudes and practices rather than socio-economic background which determine parent-child relationships, child interest and attitudes (11).

3. *Intelligence*

Table 2 shows the means and *SD*s obtained by the Jewish preschool children on all tests.

Note that the Revised Stanford Binet *IQ* of 116.64 is similar to the

TABLE 1
MEAN REVISED STANFORD AND *WISC* PERFORMANCE *IQ*S OF THE BOYS AND GIRLS ACCORDING TO FATHER'S OCCUPATION

	Boys			*Girls*			*Total*		
	N	Revised Binet	WISC Perf.	N	Revised Binet	WISC Perf.	N	Revised Binet	WISC Perf.
1. Professional, technical, and kindred workers	14	119.93	107.14	13	116.77	104.31	27	118.22	105.78
2. Managers, officials, and proprietors	9	118.11	109.33	6	112.33	105.83	15	115.80	107.93
3. Craftsmen, foremen, and kindred workers (skilled)	11	117.18	100.73	8	110.75	98.87	19	114.47	99.95
4. Operatives and kindred workers (semi-skilled)	12	117.58	105.83	11	114.18	95.09	23	115.96	100.70
5. Clerical, sales, and kindred workers	12	117.75	108.92	21	116.05	105.10	33	116.67	106.48

author's findings in a previous study of the intelligence of applicants for admission to day schools (18). In that study, the mean *IQ* was 114.88 with an *SD* of 12.87. We may further note that the *WISC* Full scale *IQ* and even *WISC* Verbal *IQ* are not as appropriate for the Jewish preschool child of traditional background as is the Binet. The difference between the means of the Binet and *WISC* full scale *IQ* is 11.02. The standard error of the differences is 1.79 and the *CR* is 6.16. This difference is statistically reliable at .01 per cent level of confidence. This difference may be due to the fact that (*a*) the Binet and *WISC* are not strictly comparable as they have been standardized on different populations, certain different tests, and thus measure somewhat different areas at this level (see section under previous research) or (*b*) the Jewish traditional home fosters activities which have a higher premium on Binet than *WISC*.

TABLE 2
MEANS, AND *SDs* OBTAINED BY JEWISH PRESCHOOL CHILDREN ON ALL TESTS

	N	Mean	SD
Revised Stanford Binet	117	116.64	13.84
Binet M. A.	117	6.46	0.77
Binet Performance	117	13.86	1.60
WISC Full	117	105.62	13.52
WISC Verbal	117	105.51	14.41
WISC Performance	117	104.43	11.96
Progressive Coloured Matrices	104	14.83	2.88
Goodenough Draw A Man	80	12.53	2.89
WISC Verbal			
Information	117	10.85	3.65
Comprehension	117	11.78	3.54
Arithmetic	117	11.38	3.08
Similarities	117	10.79	3.07
Vocabulary	117	9.23	3.02
WISC Performance			
Picture Completion	117	10.19	3.37
Picture Arrangement	117	11.16	3.04
Block Design	117	10.39	2.71
Object Assembly	117	9.88	2.97
Coding	117	9.69	2.36

4. *Bilingualism*

Another question arises as to whether there is any correlation between socio-economic background, intelligence, and bilingualism for our groups.

Table 3 shows the Revised Stanford-Binet and *WISC* performance scale *IQs* of the monolingual and bilingual children according to father's occupation.

TABLE 3

MEAN REVISED STANFORD BINET AND *WISC* IQS OF THE MONOLINGUAL AND BILINGUAL CHILDREN ACCORDING TO FATHER'S OCCUPATION

	Monolingual			*Bilingual*			*Total*		
	N	Revised Binet	WISC Perf.	N	Revised Binet	WISC Perf.	N	Revised Binet	WISC Perf.
1. Professional, technical and kindred workers	15	123.2	107.33	12	112.0	103.15	27	118.22	105.78
2. Managers, officials, and proprietors	6	117.0	112.34	9	115.0	104.67	15	115.8	107.93
3. Craftsmen, foremen, and kindred workers (skilled)	13	118.08	102.31	6	106.67	94.83	19	114.47	99.95
4. Operatives and kindred workers (semi-skilled)	7	123.71	110.00	16	112.56	96.63	23	115.96	100.70
5. Clerical, sales, and kindred workers	16	119.43	108.50	17	113.65	104.59	33	116.67	106.48

An examination of Table 3 shows that, for our sample, there is only a chance relationship existing between the socio-economic background and either verbal or performance ability for both the monolingual and bilingual groups.

In studying Table 3, one must remember, however, that in the case of the bilingual children, the parental occupation may not have been a true index of the cultural level of the family. It is quite possible that, due to the language handicap, the present occupation of the parent of the bilingual group did not correspond to his cultural level.

A collateral problem is whether bilingualism affects the scores on the intelligence tests.

TABLE 4

SIGNIFICANCE OF THE DIFFERENCES BETWEEN THE MEANS OF THE TESTS OF MONOLINGUAL AND BILINGUAL BOYS*

	Monolingual		*Bilingual*				
	N	Mean	N	Mean	Diff.	SEm	t
Revised Stanford Binet	29	120.83	29	116.31	4.52	4.07	1.11
Binet MA	29	6.70	29	6.40	.30	.22	1.36
Binet Performance	29	13.98	29	13.77	.21	.32	.66
WISC Full	29	110.58	29	108.34	2.24	3.77	.59
WISC Verbal	29	110.24	29	110.55	.31	4.23	–.07
WISC Performance	29	108.86	29	103.86	5.00	3.30	1.52
Raven Coloured Matrices	22	15.86	27	14.04	1.82	1.13	1.61
Goodenough Draw A Man	21	12.14	17	12.12	.02	.74	.03
WISC Verbal subtests							
Information	29	11.69	29	11.93	.24	1.07	–.22
Comprehension	29	12.31	29	12.83	.52	1.16	–.45
Arithmetic	29	12.00	29	12.10	.10	.79	–.13
Similarities	29	10.38	29	11.72	1.34	1.04	–1.29
Vocabulary	29	11.24	29	8.83	2.41	1.20	2.01
WISC Performance subtests							
Picture Completion	29	11.00	28	11.03	.03	1.11	–.03
Picture Arrangement	29	12.31	29	10.72	1.59	.87	1.83
Block Design	29	10.76	29	10.07	.69	.73	.95
Object Assembly	29	10.13	29	10.38	.25	.98	–.26
Coding	29	9.37	29	9.24	.13	1.20	.11

* A minus sign indicates a difference in favor of the bilingual boys.

Table 4 shows the significance of the differences between the means of the tests of the monolingual and bilingual boys.

An analysis of Table 4 indicates that these differences are statistically not significant. Note that while seven of 18 differences are in favor of the bilingual boys, 11 differences are in favor of the monolingual boys.

Table 5 shows the significance of the differences between the means of the tests of monolingual and bilingual girls.

Note that only three differences which are statistically not significant are in favor of the bilingual girls; all the other differences are in favor of the monolingual girls. Of these, differences in Revised Stanford-Binet, Binet *MA*, *WISC* Full, *WISC* Verbal, *WISC* Performance, Similarities, and Picture Arrangement are statistically significant. Note that on the tests which are more heavily loaded with verbal items, the bilingual girls make out poorer than on those which have more performance items. The only exception to this observation is Picture Arrangement, which at the younger ages correlates equally well with verbal as well as performance items (31). Apparently bilingualism is a greater handicap to the girl than to the boy, as girls traditionally earn a greater proportion of their scores on verbal tests. It is well known that girls begin speaking earlier than boys, preschool girls have a larger vocabulary than boys, and speak longer sentences than boys.

TABLE 5
SIGNIFICANCE OF THE DIFFERENCES BETWEEN THE MEANS OF THE TESTS OF MONOLINGUAL AND BILINGUAL GIRLS

	Monolingual		*Bilingual*				
	N	Mean	N	Mean	Diff.	SEm	t
Revised Stanford-Binet	28	120.18	31	109.87	10.31	3.28	3.14**
Binet MA	28	6.58	31	6.17	.41	.17	2.41*
Binet Performance	28	13.94	31	13.96	.02	.46	–.04
WISC Full	28	106.72	31	97.45	9.27	2.34	3.96**
WISC Verbal	28	106.24	31	95.70	10.54	2.59	4.07**
WISC Performance	28	105.85	31	99.52	6.33	3.01	2.10*
Raven Coloured Matrices	24	14.87	31	14.74	.13	.88	.15
Goodenough Draw-A-Man	20	12.15	22	13.54	1.39	1.51	–.92
WISC Verbal subtests							
Information	28	10.78	31	9.01	1.77	.97	1.82
Comprehension	28	11.61	31	10.45	1.16	1.05	1.10
Arithmetic	28	11.39	31	10.09	1.30	.92	1.41
Similarities	28	11.25	31	9.16	2.09	.92	2.27*
Vocabulary	28	9.25	31	7.71	1.54	.98	1.57
WISC Performance subtests							
Picture Completion	28	10.93	31	10.23	.70	.85	.82
Picture Arrangement	28	12.07	31	9.68	2.39	.93	2.57*
Block Design	28	10.36	31	10.38	.02	.81	–.02
Object Assembly	28	9.82	31	9.23	.59	.78	.76
Coding	28	10.10	31	10.03	.07	1.01	.07

* .05 level of confidence.
** .01 level of confidence.
A minus sign indicates a difference in favor of the bilingual girls.

5. *Sex Differences*

Table 6 shows the significance of the differences between the means of the tests of the boys and girls.

Analysis of Table 6 indicates that only three of the 18 differences are in favor of the girls and these are statistically not significant, whereas, of the 15 remaining differences in favor of the boys, six are significant either at the five per cent or at the one per cent level of confidence. These tests are: *WISC* full scale, *WISC* verbal, *WISC* verbal subtests: Information, Comprehension, Arithmetic, and Vocabulary.

TABLE 6
SIGNIFICANCE OF THE DIFFERENCES BETWEEN THE MEANS OF THE TESTS OF THE BOYS AND GIRLS

	N	*Boys* Mean	N	*Girls* Mean	Diff.	SEm	t
Revised Stanford Binet	58	118.57	59	114.76	3.81	2.72	1.40
Binet MA	58	6.55	59	6.36	.19	.16	1.19
Binet Performance	58	13.88	59	13.95	.07	.37	–.19
WISC Full	58	109.46	59	101.85	7.61	2.36	3.22**
WISC Verbal	58	110.40	59	100.70	9.70	2.64	3.67**
WISC Performance	58	106.36	59	102.52	3.84	2.16	1.78
Raven Coloured Matrices	49	14.86	55	14.79	.07	.57	.12
Goodenough Draw A Man	38	12.13	42	12.88	.75	.84	–.89
WISC Verbal							
Information	58	11.81	59	9.85	1.96	.67	2.93**
Comprehension	58	12.57	59	11.00	1.48	.68	2.18*
Arithmetic	58	12.05	59	10.71	1.34	.59	2.27*
Similarities	58	11.05	59	10.15	.90	.58	1.55
Vocabulary	58	10.04	59	8.44	1.60	.80	2.00*
WISC Performance							
Picture Completion	58	11.02	59	10.56	.46	.72	.64
Picture Arrangement	58	11.52	59	10.81	.71	.59	1.20
Block Design	58	10.42	59	10.37	.05	.53	.09
Object Assembly	58	10.26	59	9.51	.75	.69	1.09
Coding	58	9.31	59	10.06	.75	.74	–1.01

* .05 level of confidence.
** .01 level of confidence.
A minus sign indicates a difference in favor of the girls.

It is worthwhile to observe the differences in the performance of the boys and girls in the various intelligence tests. In those tests which are based upon materials which are more subject to learning (*WISC* verbal subtests), the boys are clearly superior to the girls. In those tests (Binet), however, in which a high score depends not so much upon incidental information picked up, but upon general intellectual ability, while the boys do better, the difference in their favor is statistically not significant. We also must remember, however, that girls generally have a higher *WISC* performance *IQ* at this age (25) and also do better on Binet preschool performance items (22, p. 51).

The differences in favor of the girls on the Goodenough Draw-A-Man test and Coding may be due to the fact that girls generally put more details in their drawing of a man than do boys (8) and are more perceptive of small details.

The superiority of the Jewish boy becomes even more evident in light of the factors cited above and also in view of both the *WISC* standardization data (26) and other research studies reported (8). Does the emphasis in the Jewish home on the boy's intellectual achievements bring this about? Does the Jewish boy develop a self-concept of an achiever and, therefore, tries harder on intelligence tests?

Are there other factors which may account for these findings? In other words, are these real sex differences, or do artifacts of the sample such as bilingualism bring this about?

Exactly what is the significance of sex factors, for our sample, in a monolingual and bilingual situation?

Table 7 shows the significance of the differences between the means of the tests, of the monolingual boys and girls.

Table 7 indicates that 15 out of 18 differences are in favor of the monolingual boys. None of these are statistically significant however. The combined differences in favor of the boys, however, is at the one per cent level of confidence.

TABLE 7

SIGNIFICANCE OF THE DIFFERENCES BETWEEN THE MEANS OF THE TESTS OF THE MONOLINGUAL BOYS AND GIRLS*

	Boys		*Girls*				
	N	Mean	N	Mean	Diff.	SEm	t
Revised Stanford-Binet	29	120.83	28	120.18	.65	4.29	.15
Binet MA	29	6.70	28	6.58	.12	.23	.52
Binet Performance	29	13.98	28	13.94	.04	.45	.09
WISC Full	29	110.58	28	106.72	3.86	3.07	1.26
WISC Verbal	29	110.24	28	106.24	4.00	3.42	1.17
WISC Performance	29	108.86	28	105.85	3.01	2.89	1.04
Raven Coloured Matrices	29	15.86	24	14.87	.99	1.29	.77
Goodenough Draw-A-Man	21	12.14	20	12.15	.01	1.43	–.01
WISC Verbal							
Information	29	11.69	28	10.78	.91	.85	1.07
Comprehension	29	12.31	28	11.61	.70	1.07	.65
Arithmetic	29	12.00	28	11.39	.61	.77	.79
Similarities	29	10.38	28	11.25	.87	1.01	–.86
Vocabulary	29	11.24	28	9.25	1.99	1.09	1.83
WISC Performance							
Picture Completion	29	11.00	28	10.93	.07	1.10	.06
Picture Arrangement	29	12.31	28	12.07	.24	.92	.26
Block Design	29	10.76	28	10.36	.40	.83	.48
Object Assembly	29	10.13	28	9.82	.31	.89	.35
Coding	29	9.37	28	10.10	.73	1.26	–.58

* A minus sign indicates a difference in favor of the girls.

Table 8 shows the significance of the differences between the means of the tests of the bilingual boys and girls.

Table 8 indicates that five out of the 18 differences between the means of the scores are in favor of the girls. However, these are not statistically significant. On the other hand, seven out of 13 differences in favor of the boys are significant at either the five per cent or at the one per cent level of confidence. These tests are Revised Stanford-Binet, *WISC* Full scale, *WISC* Verbal scale, and the Information, Comprehension, Arithmetic, and Similarities subtests of the *WISC* Verbal scale.

TABLE 8

SIGNIFICANCE OF THE DIFFERENCES BETWEEN THE MEANS OF THE TESTS OF THE BILINGUAL BOYS AND GIRLS

	Boys		*Girls*				
	N	Mean	N	Mean	Diff.	SEm	t
Revised Stanford-Binet	29	116.31	31	109.87	6.44	2.86	2.25*
Binet MA	29	6.40	31	6.17	.23	.17	1.35
Binet Performance	29	13.57	31	13.96	.39	.35	−1.11
WISC Full	29	108.34	31	97.45	10.89	3.20	3.40**
WISC Verbal	29	110.55	31	95.70	14.85	3.59	4.14**
WISC Performance	29	103.86	31	99.52	4.34	3.50	1.24
Raven Coloured Matrices	27	14.04	31	14.74	.70	.62	−1.13
Goodenough Draw-A-Man	17	12.12	22	13.54	1.42	1.64	−.87
WISC Verbal subtests							
Information	29	11.93	31	9.01	2.92	1.17	2.50*
Comprehension	29	12.83	31	10.45	2.38	1.14	2.09*
Arithmetic	29	12.10	31	10.09	2.01	.93	2.16*
Similarities	29	11.72	31	9.16	2.56	.95	2.69*
Vocabulary	29	8.83	31	7.71	1.12	1.10	1.02
WISC Performance subtests							
Picture Completion	29	11.03	31	10.23	.80	.86	.93
Picture Arrangement	29	10.72	31	9.68	1.04	1.33	.78
Block Design	29	10.07	31	10.38	.31	.84	−.37
Object Assembly	29	10.38	31	9.23	1.15	.88	1.31
Coding	29	9.24	31	10.03	.79	.94	−.84

* .05 level of confidence.
** .01 level of confidence.
A minus sign indicates a difference in favor of the girls.

It appears that many factors, some of which most likely were not mentioned in this paper, bring about a higher achievement on the tests for the boys. However, the trend of the data is to the effect that the cultural impact of the Jewish home plays a large, if not a major part in the differences found in favor of the boys. It appears to the writer, therefore, that some consideration be given to separate norms for the sexes.

6. *Verbal and Performance Abilities*

Table 9 shows the significance of the differences between the means of the *WISC* verbal and *WISC* performance scales.

An analysis of Table 9 indicates that for the entire group, the verbal scores are higher than the performance scores. These differences, however, are statistically insignificant. Further analysis of the table, however, indicates that both bilingual and sex factors have contributed to this difference. We may note that the boys' verbal scores are significantly higher at .05 level of confidence than the performance scores; yet only the bilingual boys' verbal scores are significantly higher. The girls, on the other hand, have higher performance than verbal scores. These, however, are statistically not significant. A further analysis of this indicates that, while the bilingual girls' performance scores are higher than the verbal scores and approach statistical significance, the monolingual girls' verbal scores, however, are higher than performance scores.

TABLE 9
SIGNIFICANCE OF THE DIFFERENCES BETWEEN *WISC* VERBAL AND *WISC* PERFORMANCE SCALES

	N	Verbal Mean	Performance Mean	Diff.	SEm	t
Entire group	117	105.51	104.43	1.08	1.19	+.91
Boys	58	110.40	106.36	4.04	1.78	+2.27*
Girls	59	100.70	102.52	1.82	1.35	=1.35
Monolingual	57	108.63	107.39	1.24	1.48	+.84
Bilingual	60	103.03	101.62	1.41	1.67	+.84
Monol. boys	29	110.24	108.86	1.38	2.27	+.61
Biling. boys	29	110.55	103.86	6.69	2.68	+2.50*
Monoling. girls	28	106.24	105.85	.39	1.66	+.23
Biling. girls	31	95.70	99.52	3.82	2.14	=1.79

* .05 level of confidence.
+ Verbal higher.
= Performance higher.

We may conclude, therefore, that in Jewish children of traditional parentage, there is a tendency for the verbal scores of monolingual children whether they are boys or girls to be higher than performance scores. With the bilingual children, however, the boys' verbal scores tend to be significantly higher than performance scores and the girls' verbal scores tend to be lower than the performance scores.

It thus appears that, in the preschool years, there already is a difference between verbal and performance abilities of Jewish boys of traditional parentage. Apparently cultural forces are more operative with boys than with girls. It is to be noted that previous research has indicated that the preschool bilingual children have a higher performance than verbal intelligence. In our case, we found it to be valid with girls and not with boys.

D. Discussion

Our study has indicated that differences do exist between verbal and performance abilities of Jewish children which depend upon (*a*) sex and (*b*) bilingualism. In the preschool years, differences already appear between the verbal and performance abilities of Jewish children of traditional parentage which apparently foreshadow the much larger differences which are found in subjects attending elementary schools, high schools, and colleges. Apparently subcultural forces are operating which are modified by sexual and bilingual factors. Since the magnitude of the differences found is much larger in the later years than in the preschool years, it is of interest to learn what increases these differences. Three hypotheses may be entertained: (*a*) that this differentiation in abilities in favor of verbal intelligence is further fostered by the school, the community, and the home, or (*b*) these differences only affect the boys and not the girls (it is to be noted that the subjects reported in the literature were in the overwhelming number of instances males); or (*c*) that the highly verbal child is selected by the school and the performance-minded is left by the wayside. Whichever hypothesis may be valid, if this differentiation of abilities is thought undesirable, might not the trend be reversed by modifying the curriculum?

E. Summary

It is well known that Jewish subjects usually have higher verbal than performance abilities. A study was made to determine (*a*) whether these differences are also found at the preschool level and, (*b*) what influence, if any, did socio-economic factors, bilingualism, and sex have on these differences.

The Revised Stanford-Binet, *WISC,* Raven Progressive Coloured Matrices, and Goodenough Draw-A-Man Test were administered to 58 boys and 59 girls aged 5 to 6. These children, who were of traditional Jewish parentage, were applicants for admission to traditional day (Yeshiva) schools.

1. *Socio-Economic Background*

There was no relationship found between socio-economic background and the Revised Stanford-Binet or *WISC* performance *IQ*s.

2. *Bilingualism*

Among the boys, the monolinguals had higher scores on 11 out of 18 subtests. None of these differences were statistically reliable. Among the girls, however, the monolinguals had higher scores on 15 subtests. Of these, the scores on Revised Stanford-Binet, Binet *MA, WISC* Full, *WISC* Verbal,

WISC Performance, Similarities, and Picture Arrangement were significantly higher.

3. *Sex Differences*

(*a*) For the group as a whole the boys had higher scores on 15 subtests. Of these, they had significantly higher scores on *WISC* Full, *WISC* Verbal and the following *WISC* Verbal subtests: Information, Comprehension, Arithmetic and Vocabulary. (*b*) While 15 of the differences for the monolingual children were in favor of the boys, none of these were statistically significant. (*c*) Yet, for the bilingual children, the boys had higher scores on 13 subtests and, of these, they were significantly higher on Revised Stanford Binet, *WISC* Full, *WISC* Verbal, and the following *WISC* Verbal subtests: Information, Comprehension, Arithmetic, and Similarities. These differences, in favor of the boys, were hypothesized to be due to the emphasis of the Jewish traditional home on scholastic achievement for the boys.

4. *Verbal and Performance Abilities*

The *WISC* Verbal and Performance *IQ*s were analyzed. For the entire group, the verbal scores were higher than the performance scores. These differences, however, were statistically not reliable. The boys' verbal scores were significantly higher than the performance scores. The girls, on the other hand, had higher performance than verbal scores. These were not statistically significant. Bilingual factors served to increase the verbal ability of the boys and depress that of the girls.

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THE EVOLUTION OF VERTEBRATE PERCEPTION*

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In any general survey of the evolution of life, the biologist is somewhat in the position of the archaeologist who has discovered a new language but has not deciphered its meaning. A fabulous record appears of organization and super-organization of life units, the fuller meaning of which has thus far evaded apprehension. In symbolic terms one might say that the story is one of integration, ever higher integration but somehow the integration of a mosquito seems no less miraculous than the integration which constituted the intellect of Shakespeare, irrespective of the discomfort and possible illness communicated by the one and the inspiration given by the other. Some additional dimension of deeper significance would seem to be present which thus far has evaded perception. Perhaps a consideration of perception itself may reveal some sense of the meaning of the great and awesome and wonderful evolution of life.

A. VERTEBRATE AND INVERTEBRATE PERCEPTION

The subdivision of the animal kingdom into invertebrates and vertebrates constitutes an evolutionary differentiation of profound significance. From a paleontological point of view, the vertebrate is a neo-metazoan, a phylum originating in and developing since the Ordovician as contrasted to the emergence of the invertebrate phyla in the pre-Cambrian era. From a morphological point of view, a distinctive patterning of structures links the lowest to the highest classes in an unequivocal design. From a behavioral point of view, a certain quality which might be termed "object apprehension" or an increased sensory responsiveness to objects seems to distinguish the lowest to the highest vertebrate from the quasi-plant like automaticity and mechanicalness of invertebrates. One feels that the lowly fish eating his prey is more aware of his object than the wasp stinging the spider even though the latter is doing a more exact and expert job.

This difference in behavior is based on two main features of the vertebrate patterning. The first is the universal presence of a lens eye enabling the organism to fixate on and define near and distant objects and the second

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is the growth of the diencephalon or thalamus for re-recording to the organism the inner states it is experiencing. Both the increase in object definition and subjective responsiveness give the vertebrate reaction a subject-object, "emotional" quality as compared with the apparently cold, mechanical, impersonal reaction of the invertebrates. The invertebrate seems like a pure stimulus-response organism; intricate circuits of reflex arcs akin to a calculating machine. The vertebrate is more a stimulus-feeling-responding organism, intricate circuits of reflex arcs with some variety of inner awareness both of the object and the organism's needs interposed between stimulus and response.

The primary vertebrate sensory mechanism for this element in their perceptuality is the lens eye, universal amid this phylum except in the rare instances of secondary degeneration, and a distinctive possession of only the vertebrates and the mollusks. It is by this means that a clearly defined image of the objective world is made possible. The compound eye of the insects has its own special achievements that in some ways surpass the lens eye such as the capacity to respond to polarized light and thus use the sun's rays for orientation purposes as a mechanism in aerial navigation as recently demonstrated in bees by Von Fritsch. Acute visual response to near objects is clearly present but a clear holistic visual image of near and distant objects would seem to be optically impossible.

In all vertebrates, from the lowest cyclostome to the highest birds and mammals, a well developed lens eye is present except, as stated, where this has undergone a secondary degeneration (10). In a sense, the basic pattern of the vertebrate nervous system is a brain and spinal cord organized around an eye with vision as the dominant sense modality of all except the mammals. Romer (11) points this out in connection with reptiles but the same is true of all vertebrates except mammals. This was clearly demonstrated by the work of Ehrenhardt (3) who showed that reptiles offered food with a visual cue they avoid such a rough outline refuse it in preference for quinine when offered with the smooth outline they prefer. Salamanders behave similarly (12). Visual dominance in fishes seems equally prevalent as shown by Tinbergen's work (15) on the stickleback, though, of course, there may be exceptions in various species. The neurological expression of this pattern is the universal development from the mesencephalon of a special center for visual perception, the optic lobe which remains anatomically independent of the prosencephalon until the telencephalization of the mammals (8).

The grand achievement of the vertebrate eye and nervous system in bringing into sharp focus the three space dimensions and then with binocular vision making more exact the third space dimension of depth forms the basis of all later developments. By this means life forms from fishes to mammals and birds acquired the power to navigate amid, and integrate to concrete perceived shapes and forms; acquired what in philosophical terms has been defined as the concept of space, granting some sense of the object as such or the object amid objects. This should be distinguished from the invertebrate reaction to objects as experiences solely related to motor or instinct ends. The lens eye granted the vertebrate full and complete visual images of the external world around which instincts with their sensory and motor patterns could become subordinated and integrated.

The higher reception and registration of objects located in the three space dimensions constitutes the major achievement of life in the perceptual sphere up to the emergence of the mammals wherein further advances in perceptuality were achieved. This constitutes about two-thirds the total period in which vertebrates have been on the earth. The next great transformation consisted of the emergence of mammals wherein, for the first time since the origination of the vertebrates, the entire structure of the brain and the basic behavior pattern underwent a radical transformation. From cyclostome to bird, the mesencephalon or optic lobe remained anatomically independent of the fore-brain as an expression of the dominance of vision. With the emergence of the mammal—found even in the monotreme—the major mesencephalic functions became absorbed by the cerebral cortex in what has been termed telencephalization. With this, visual dominance became generally superceded by olfactory or auditory dominance. To understand the significance of this great transformation in perception it is necessary to consider some of the broader aspects of the emergence of the mammal.

B. MAMMALIANISM

One of the most recent universal transformations of life, reflected grossly in both the vertebrates and the plant kingdom, was that which occurred with the emergence of mammals, birds, and angiosperms since the Jurassic some 150,000,000 years ago. A "sexual revolution" would seem to have occurred with the emergence of the two higher classes of vertebrates and the highest class of plants all of whom developed more complex, involved, and advanced reproductive mechanisms granting the germinating immature more perfect mechanisms for survival and maturation. Angiosperms provide their seed with a closed capsule or ovary, higher mammals provide their fetuses with a uterus and their immature with specialized nutrient substances from mammae, birds brood their eggs and nurture their young. In other words, a "devotion to reproduction" appeared amid these highest forms of life. A similar effect, occurring more sporadically would seem to have developed amid the lower vertebrates and the invertebrates such as the insects.

Although it is obvious that advances in reproductive efficiency are manifest before the Jurassic as expressed in cleavage and egg changes, still the proliferation of classes of animals and plants with these facilities as class specific suggests some special influence, a kind of "nurture force" moulding the tissues and instincts of the highest plants and animals. Such a nurture force must obviously have something to do with the more general phenomenon of metazoan development with its mechanism of germinal substances controlling the development of the species and of the individual. Inasmuch as all higher metazoans reproduce by germination, it can be said that some Evolutionary Force (or Forces) has created the germ substance to provide both for the new organism and structures and functions for the care of further, subsequent generations of organisms. This nurture force is thus somehow condensed in the germ substances of higher organisms.

The various advantages of the mammalian scheme of reproduction in allowing security for a more slow, intricate, and exquisite organization of the fetus and immature is obvious on a moment's consideration. As compared with the "assembly line" reproduction of lower organisms, each nascent mammal is granted protection and care which enables it to become a more perfect and polished organism. Through intra-uterine fetal growth, its life is automatically protected by the survival instincts of the mother. By means of nurturing instincts which appear in the mother at birth, this devotion to its well being is prolonged to its maturity. By virtue of this prolongation of immaturity, a kind of "foetalization" as described by Bolk (1), the young mammal has been enabled to base its developing motility patterns more and more on the basis of perception gained from experience rather than the ingrained congenital perceptual patternings of the lower forms of life. This has contributed significantly to the mammal's plasticity of behavior or "modifiability" as described by Maier and Schnierla (7).

Nurturing is achieved by creating individuals whose somatic tissues and the nervous system with their instincts are dedicated to species reproduction along with the germ cells *per se*. This should be contrasted with the mere expulsion of potential reproductive gametes in non-nurturing forms of life wherein the somatic tissues are almost exclusively devoted to the survival of the individual except for short periods during mating and egg laying. Through this devotion to reproduction prolonging the concern with this activity, the somatic or "egoistic" drives of the individual members of the species become modified for extended periods to secure the well-being and survival of the dependent immature. The sexual instincts fuse with the somatic, which fusion probably contributes to the generalized instinctual enhancement or increase in drive and activity to be noted in the nurturing classes generally (mammals and birds) as compared with non-nurturers generally (reptiles and amphibians).

The above changes in reproduction which occurred with the emergence of the mammals was accompanied by and in part predicated on a growth of eroticism transforming the skin surfaces and the innervation of the intestinal orifices. Hair and mammae came into being and the skin generally became charged or infiltrated with increased sensory neurone supplies as well as the mouth and anus. The phenomenon of skin, oral, and anal eroticism and excitement became a mechanism for courtship and sexual play amid the mature and for nutritive connection (searching and sucking by the nursling, acceptance and nursing by the mother). This phenomenon—the sexualization or erotization of the body surfaces and the intestinal orifices requiring an increased sensory capacity of the body surface—must inevitably have stimulated a corresponding growth of the central nervous system's areas for sensory reception in the brain. Thus the eroticism of mammalianism tended to expand the sensory capacity and areas of the brain, giving rise to the generally expanded brains of the mammals—as compared with the reptiles.

C. TELENCEPHALIZATION

In the emergence of the mammal, two radical perceptual transformations occurred of profound and far reaching significance. These consist of the elaboration of two non-visual sense modalities—olfaction and audition, both of which developed perfected sense organs as compared with the reptile. In the earliest and in most mammals, olfaction has come to dominate the sensory activity of the brain as expressed anatomically by telencephalization or the absorption of visual activity into the smell brain. In a few orders this has been superceded, with even more profound consequences, as in man, by auditory domination. First the significance of olfactory dominance will be considered and then that of audition as they occur in mammalian evolution.

With the shift from visual to olfactory domination, smell triumphed over sight. Smell perception is essentially a highly perfected form of chemo-reception. Particles of the external world are incorporated in minute amounts and "chemically analyzed" or evaluated by the olfactory sense organ and brain areas. With this has occurred a vast expansion of cerebral substance, culminating in the massive cerebrum of the whale and elephant and the less massive but incomparably more efficient brain of man. A further transformation amid the primates, chiroptera, and cetacea (2) consisted of the suppression of olfaction in favor of auditory dominance accompanied (in the primates) by the growth or regrowth of foveal vision.

In evaluating these changes, particularly the shift from visual to olfactory domination, one is reminded of the old adage that "appearances are deceiving." One also thinks of the great advances in all areas from medicine to manufacturing which chemistry—or the apprehension of material substances, has granted man's control over nature. Most physicians depend more on a urinalysis, blood chemistry, etc., than the appearance of a patient in their diagnostic conclusions, despite the glorification of the older methods. With the growth—or perhaps one would say re-growth of olfactory perception, for invertebrates would seem to depend more on chemo-reception than visual perception—the mammal acquired a means for more exactly testing and evaluating the inner nature, the essence, rather than the "outward show" of the objects around him. A "materialist" form of life came into being, replacing and later dominating his "image worshipping" ancestors and their more direct descendants.

But there is more to this shift to olfaction than the power of detecting the essences of things. Visual perception is limited by its deficiencies as a nocturnal mode of perception, by the field it subsumes, and by the necessity for rest which suspends its activities. Smell is active nocturnally as well as diurnally, is global, and would seem in many animals to be incessantly receptive, active with each breath the individual takes. It has been suggested that the earliest mammals were nocturnal and their advance in olfaction would give them an advantage over more visually bound forms of life. Also they would seem to have been fossorial as well which requires for effectuality a keen sense of smell. Thus, a return to "the mud and the muck" to a delight in smell by a form of reptile began what became the greatest advance in all of life.

This shift in perceptual dominance was undoubtedly connected with the expansion of the angiosperms, covering the earth with a dense foliage, interfering with vision, and thus granting non-visual modes of perception a significant advantage over pure visual perception. The rise of both birds—who succeeded in rising above the foliage and mammals who were able to smell and hear their way around and the widespread extinction of the larger and more conspicuous reptiles was undoubtedly related to this change in the earth's vegetation.

In addition to the above advantages of olfactory over visual dominance, there are other factors to account for telencephalization. The work of Lorenz (6), describing "imprinting" in the vision dominated young bird demonstrates that this modality tends to be more fixed and rigid than olfaction. The vast increase in plasticity, and learning capacity characteristic of the mammal over other vertebrates is undoubtedly related to olfaction's greater sensory variability and flexibility. The neocortex would seem to have subsequently come into dominance because of some biochemical capacity to manufacture perceptual surfaces or receptivity to new stimuli and a capacity for re-arranging motor behavior more completely on the basis of individual, learned experience facilitated by the mammal's slower development. This expansion of sensory capacity in the mammal has undoubtedly been stimulated by the increased brain sensory representation caused by the skin and orifice eroticism of the mammal.

Further, the expansion of the neopallium seen in mammals constitutes a kind of second thalamus, reduplicating on a higher level the achievement of the lower vertebrates and greatly increasing the awareness of internal processes of the mammal. The overlaying of visual imagery with olfactory or auditory sensation would seem to negate the fixity of the instinct image-action pattern (13) so that new perceptions can modify old ones, thus preventing earlier memories from distorting new experiences. It is by this means that flexibility and the all important ability to continue to learn from and correct, or reality test, past experience arises.

Another important advance in perceptual capacity which was wrought by the development of olfaction consisted in the ability to detect variations and sequences of intensity, following the experience in the external world of the odor change with time on the trail of any animal. Intensity variations are of great importance in the olfactory sense for following an old spoor wastes valuable time and energy and the proper direction of a trail can only be appreciated by comparing present sniffs with previous ones. From this "lowly" beginning would seem to arise the origins of the fourth dimension, present in animals as an awareness of correct sequences of past events and in man as his sense of time. Visual experiences may vary in intensity but they are either present or absent. This may give some slight past awareness but not the consciousness of the recent or the remote as told by smell perception. Visual memory has more of the sense of "timelessness" as described by Freud for the unconscious (4) and seen in the dream. The odor left by an animal describes the recency of its presence to the keen smeller. The clinical neurological expression of this connection of olfaction and time is the déjà vue experience or sense of being in the past seen in lesions of the rhinencephalon or smell brain in man.

In these shifts in perceptuality, a major feature in Evolution may be detected. With the proliferation of even the lower mammalian brain, a form of life become ever more fully integrated to the phenomena of the external world. Perception became nocturnal as well as diurnal, capable of apprehending substance or essence as well as form, global as well as focussed and field, increasingly plastic and experience related and able to evaluate sequences of past events. In other words, a class of life arose whose nervous system was adapted ever more acutely and exactly to the qualities of the real world just as its metabolism—its homothermy made it better able to adapt to external heat changes. Sense organs, sensory and motor neural circuits became moulded to more completely attune the individual species to the objective qualities of the environment. Such a phenomenon may perhaps be termed "Objectification" and consists in creating tissues and substances in response to the conditions of objective reality.

Objectification in essence contains two main processes—the increasing of perceptual range and the creation and perfection of neural structures to integrate the organism to this expanded perceptuality. It should be sharply distinguished from adaptation which merely secures survival and is a passive phase of this process. Objectification impels the organism, not only to survive, but also to perfect itself which surge for higher integration may be paid for by species extermination. The survival of simpler, more archaic forms of life from the earliest ages clearly demonstrates that adaptation or survival is insufficient to explain evolutionary advance. Something within the organism, perhaps stimulated by something from without, seeks advance and perfection or a higher integration of the organs of the organism. Just how this process is accomplished is as obscure as the essence of gravitation or electricity, yet that it occurs is as clear from the paleontological, embryological and, as outlined above, from the ethological record as any of the physical phenomena of nature.

D. AUDITORIZATION

There are two places where smell perception offers a poor guide for global and nocturnal information and that is at higher altitudes and in the sea. For smell tends to cling to the earth and requires air dissemination for maximum effectiveness. The second type of non-visual perception, both global, nocturnal as well as diurnal or audition, whose sense organ or the cochlea had achieved a higher development in the mammal as compared with the reptile became dominant in three orders; the cetacea, the chiroptera, and the primates. Among those mammals who took to the trees and mostly remained arboreal, or the primates, the new dominant sense modality caused the proliferation of the temporal lobes which as shown by the experiments of Klüver and Bucy (5) became the dominant sense modality even in monkeys. These investigators have clearly demonstrated that sound or temporal lobe activity dominates both smell and sight in the monkey for the removal of the temporal lobes causes the animal to lose its usual powers of visual and olfactory discrimination and evaluation in regard to objects and the temporal lobectomized animal mouths things as do infants. In other words, sound replaces smell as the primary guide for the evaluation of objects.

Sound perception has many of the features of olfaction in being nocturnal as well as diurnal and global in nature but is largely independent of wind conveyance. It has the disadvantage that it does not automatically communicate the substance or the essence of the object as does smell. It is a kind of remote palpation of objects, utilizing air vibrations to receive information about distant occurrences something like a radio, radar, or television receiver. It grants the hearer the power to perceive through objects, thereby transcending material shape, form, and substance.

This power of remote perception endows sound perception with a quality of profound and far reaching significance, particularly to man whose higher intellectual faculties are largely developed in connection with its function of language. This consists of its power to "visualize" the invisible, to "materialize" the immaterial or to perceive that which is unseen and whose material body or its substance is absent. Sound registers to consciousness experiences remote from and transcending the simpler and more organically certain experiences of "seeing is believing" and smelling. By this means, the invisible and the impalpable is registered in consciousness. Herein lies the ethological root for the belief in spirits, abstract deities, and the hidden mechanisms of science; all of which are hidden, invisible, impalpable forces.

A further quality of sound, also of profound behavioral significance to man, is its greater equivocalness in relation to safety or danger. The sight of an object or its smell quickly identifies it as prey or predator. The sound of an invisible and un-smelled object generally gives less information as to its dangerousness to the individual as for example the noise made by an animal hidden behind a dense foliage. For this reason sound perception has associated with it a quicker and more intense degree of fearfulness. It is probably this connection of sound with fear that is responsible for the phenomenon that when the auditory faculties become disrupted as in schizophrenic hallucinations a state of fearfulness or paranoid delusions ensue. The association of auditory and temporal lobe processes with fear has also been experimentally demonstrated by Klüver and Bucy as shown by the lack of fearfulness in the temporal lobectomized monkey.

The fact that the shift from olfactory dominance to auditory dominance required no change in the gross patterning of the brain as occurred in the shift from visual to olfactory dominance, points to some close connection between smell and sound. Both are air born perceptual modalities—one of chemical detection and the other of mechanical vibration detection. It would seem possible that just as the mesencephalon was in essence moulded for light registration, the telencephalon is in some way an "air" reception and action organ. In the birds, who have become so exquisitely adapted to air navigation, and who have a high auditory development, the telencephalon achieves a high degree of development with the difference from mammals that in accordance with their primarily motor adjustment to air, the motor centers or the basal ganglia become highly developed rather than the sensory part or the pallium.

An additional factor in the "hyper-telencephalization" or overgrowth of the cerebrum in the higher primates was contributed by their distinctive and peculiar mode of locomotion. For the primates are basically four handed animals, accomplishing their gymnastic feats of brachiation by means of four grasping, manipulating hands possessed of high dexterity. This has stimulated and been made possible by a high and intricate capacity for motor coordination requiring centrally an expanded area for manual motor registration. The hand area of the human motor cortex occupies almost one-quarter of its surface (9). The tracts mediating this more exact and intricate coordination are the cortico-spinal or pyramidal system unique in mammals, related to the development of the neo-pallium, and most highly developed in primates. Thus, the increased sensory capacity attendant on mammalianism's skin eroticism became joined with an increased motor capacity based on primate extremity development to provide the impetus for or as a reflection of the second massive surge of cerebral development, after the mammals generally, which characterizes the primates.

A shift in sensory dominance resembling that of the primates has occurred in the chiroptera. Here, too, the brain has been "wired for sound" and the bat's activity is largely guided by sonar consisting of sound production and reception or echolation. A similar process occurs in man wherein sounds known as words, guide and navigate the individual in his dealings with the external world. Unlike the bat, the reflux is not so accurate and exact and the significance and reality of the sounds men make or of the words they exalt to guide their behavior requires long, painful and frequently costly evaluations and re-evaluations. For the replacement of smell by sound amid the mammals "up in the air" robs the organism of the organic certainty which smell grants and substitutes abstract, nonmaterial notions about externality which can be fabulous in their correctness or in their error.

The evolutions and involutions, advances and regressions of men's "sound systems" or ideologies belong to history and social science rather than to biology. It is perhaps sufficient to point out that the apparatus which has evolved *homo* has enabled him to artificially further the general evolutionary power of objectification so that he can outfly any bird, out-swim any fish, out-burrow any fossorial animal, etc., as well as command to his will fabulous natural powers. At the same time, it has caused him to build castles—societies—civilizations in the air of empty sounds known as abstractions, verbal substitutes for reality, illusion, and delusion which recurrently and apparently inevitably tumble him into fabulous social catastrophes. In other words, a gigantic plus-minus, good-evil, preserver-destroyer of the species has come into being with the substitution in man of auditory for the sure and secure olfactory domination of his mammalian antecedents and the visual domination of his reptilian, amphibian, and fish ancestors.

E. OBJECTIFICATION

From the above can be seen how the higher perceptual powers of the vertebrates have developed. The infra-mammalian evolution centered around the lens eye and granted this phylum a clear and exact awareness of forms and objects or of the three spatial dimensions. The mammalian transformation added the fourth or a time sense, more exact material apprehension, global range, nocturnal perception through the higher development of the olfactory sense. The primate transformation added to this what is perhaps, in a sense, a kind of fifth dimension; that of the hidden, the invisible, the non-material through the development and perfection of audition as the dominant modality. The erotization, slowed maturation, sexual and somatic instinct fusion of mammalian reproduction and the digital and manual dexterity accompanying primate arboreal life each further contributed to expanding sensory capacity and motor skills.

These are the major transformations which have finally led up to the emergence of the remarkable perceptual or intellectual powers of man. Here a special patterning of perceptual faculties has led to effects and powers unique in all the history of life and so fabulous as to make man's vain claim that he is moulded in the image of God, comprehensible. As previously demonstrated (14), man's origin can be ascribed to the turning of instinct and perception inward so that not only are emotional or instinctual energies turned into the self, but man's perceptual powers become internalized as self-consciousness or apperception and the power of thinking results. These internalized instincts are particularly fused with the auditory mode overlaying the primary visual, olfactory, tactile, etc., modalities and memories. This produces an effect similar to the bat whose sound vibrations communicate invisibly with things, delimit form and objects through sonar. In man, the auditory sense is largely turned inward toward past visual, olfactory, tactile images to invisibly communicate past experiences to his consciousness by means of language. As previously stated (14), man can communicate by means of words with what he has seen or thought, felt or touched yesterday or decades ago and with the experiences of all other throughout history who would communicate or who have left some record of their activities.

Along with this fabulous range of communication, granting vast amounts of information, has arisen an intelligence which would seem to be mostly moulded out of auditory faculties with their abstract quality materialized in the intellect as the capacity to form and work with abstractions and concepts. Largely by this means, man has been enabled to psychically continue and expand nature's powers of objectification so that a greatly magnified objectification has arisen in the human species which has granted him skills that surpass any other species and vastly transcends his native motor equipment. In addition, these powers have granted him the capacity to apprehend and in part control nature's hidden mechanisms from the minute electron to the vast galaxy, from the virus and the earliest evidences of life on earth to the vital processes of the present highest forms. By this means, the neurological and morphological objectification described above has been acquired by the mind or the psyche enabling man to create and re-create nature or objectify with his mind as well as his body.

Ever since the grand and awesome panorama of evolution became apprehended and the emergence of ever higher and more developed species recognized, man has properly sought the meaning of his existence in this vast and mysterious upsurging of life which has wrought his being. So far, unfortunately, the major significance he has detected which has been used to justify the worst part of his nature has been "survival of the fittest" or the extermination of the less fit by the more fit, the less aggressive by the more aggressive. Such a conception of evolution and life inevitably leads to the exaltation of that instinct which he must tame and control or die; namely, aggression. This exclusive absorption on the crudest and most obvious mechanism in evolution, derived from the demands of animal metabolism to feed on plants and/or other animals, obscures the higher processes of evolution.

The metabolic needs of life are but mechanisms to a higher goal and their exaltation is like admiring the foundation of a magnificant cathedral and thereby being unable to see the grandeur of the structure itself. From the above evolutionary considerations, a higher mechanism of greater meaning and value to man may be discerned. This consists of slowly and gradually expanding the sensory powers of life to an ever wider and more complete awareness of the external world and of moulding the behavior of the individual to respond ever more effectively to this fuller and more complete consciousness; a process which has been termed *objectification*.

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A STUDY OF VISUAL DISCRIMINATION IN THE OPOSSUM*

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A. INTRODUCTION

Previous studies at the University of Georgia on the behavior of the opossum have shown the animal capable of forming both positive and negative conditioned avoiding responses in a relatively short time (3, 4). The opossum also learned the Guthrie-Horton box with ease (2) and, in fact, due to its undistractibility, performed better than most animals on this problem. A recent study dealt with the behavior of the animal in the Fink Arrow Maze (5), and in this type of performance the opossum showed striking ability to learn spatial relations. In the Fink maze the animal learns to locate food in four side by side alleys which run off a choice area. After food is located in one alley, and the animal runs to a criterion of 10 successive correct trials, food is shifted to another alley. The animal must learn to find food in the new alley, and is run to the same criterion. This process is repeated until all four alleys are learned. The animals studied by Fink were placed in the following order on the basis of his findings: man, pig, dog, goat, chick, cat, rabbit, and four species of turtles. The same apparatus and procedure was used with the opossum and this animal falls between man and the dog. It was quite evident that spatial learning of this type offered little difficulty to the animal.

Although the above experiments have indicated something of the learning ability of the opossum, little is known about discrimination and sensitivity in this animal.

B. PROBLEM

The present study was exploratory in nature to determine the ability of the opossum to discriminate between three pairs of visual stimuli: a white-black vertically striped card (+) versus a white card (—); a white-black horizontally striped card (+) versus a black card; and a black card with a small white triangle in the center (+), versus a white card with a small black triangle in the center (—). Each triangle was equilateral with side approximately 1¼ inch. The interest was to determine first whether the

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animal could be used in learning tests of this type, and second, to determine what criteria of learning may be expected from the animal. No definite criteria of learning were set before the experiments started.

C. Apparatus and Procedure

The apparatus was composed of a start box, a choice area, and two adjacent choice boxes with swinging doors. The choice box was two feet square. The choice doors were one-way, and could be opened only in the forward direction. The choice area was two feet wide at the start box and broadened to a four-foot width at the entrance of the choice boxes. The distance from the start box to the choice boxes was four feet. One side of the choice area was made of plate glass so that photographs could be taken on selected trials. The choice area was covered by screen wire. The start box and choice boxes were covered by ¼ inch plywood lids.

The discrimination signals were made of cardboard 7½ × 11½ inches. On the vertically striped cards were six ½ inch black stripes alternating with seven ¾ inch white spaces. The horizontally striped card had nine such black stripes and 10 white spaces. The door containing the positive card could be pushed inward permitting the animal to pass through to food and water. The door with the negative card was locked, but it could be opened inward for about two inches. Electrical contacts operated markers on a slow moving kymograph to record the sequence and number of times each door was tried by the animal before entering the food area. The position of the positive card was random. Meat was placed in both end boxes so that the animal would not choose on the basis of odor. Since the opossum eats only once a day, and usually at night, only one trial was run each night. At the beginning of the tests all doors were left open for three nights so the animal could learn that food was found in the end boxes. After this the door with the positive card was unlocked while the negative door was locked. Each morning the animal was removed from the choice box and returned to its cage until the next run.

D. Results

In order to present a total picture of the behavior during the tests, the correct choices are presented in blocks of 10 trials each in Table 1. Performance was evaluated in terms of various successive-errorless-trial criteria. Since the 10-trial block was merely a convenient way of presenting the data, the various criteria was computed on the basis of continued performance. There does not seem to be any doubt on the basis of these data that the opossum was discriminating between the positive and negative signals in each test. After a period of training the animal would perform while the observer was present, and it was quite evident the opossum was disregarding the negative signals.

TABLE 1

EVALUATION OF THE PERFORMANCE BY VARIOUS SUCCESSIVE-ERRORLESS-TRIAL CRITERIA

Blocks of 10 trials	Test 1 No. Rt.	Test 2 No. Rt.	Test 3 No. Rt.
1	4	7	5
2	4	9[1]	6
3	3	8[2]	6[1]
4	5	5	7[2]
5	6[1]	5	6[2]
6	5	9[4]	6
7	7[1]	10[5]	9[3]
8	8[1]		5[3]
9	6[2]*		

[1] Five consecutive trials, p .03.
[2] Six consecutive trials, p .01.
[3] Seven consecutive trials, p .007.
[4] Eight consecutive trials, p .0039.
[5] Ten consecutive trials, p .00097.
[*] Eleven consecutive trials over 8th and 9th blocks, p .00049.

This study, in addition to others previously mentioned, seems to indicate that the opossum learns better than might be expected, and may be used as subjects in many types of learning tests.

E. SUMMARY

The present experiment was an exploratory study on visual discrimination in the opossum. The object was to determine whether the animal could be used in a two-door discrimination test, and to learn something of the animals ability to discriminate between visual stimuli. The task set for the animal in the three respective tests was to discriminate between a white-black vertically striped card (+) versus a white card (—); a white-black horizontally striped card (+) versus a black card (—); and a black card with a small white triangle in the center (+) versus a white card with a small black triangle in the center (—). The positive card was shifted from the right to left door of a two-door discrimination box in random order. Food was placed in both food compartments, but only the positive door could be opened wide enough for the animal to enter. One trial was run each day. The animal performed usually at night in the beginning of the tests, but as the experiment progressed the animal would perform as soon as placed in the start box. In all the tests the performance of the animal was evaluated in terms of the successive-errorless-trial criterion. Results indicate that the opossum is a favorable subject to use in two-door discrimination tests involving various visual patterns.

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ASSOCIATION OF RELEVANT STIMULI ALONG A SPATIAL GRADIENT*

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A. Problem

There has been a limited number of studies (1, 3, 6) dealing with spatial contiguity per se. Using vertical separations up to four inches between the stimuli and the site of reward, McClearn and Harlow (3) found the magnitude of spatial separation to be inversely related to the efficiency of performance. Murphy and Miller (6) found that the monkey's performance on object-quality learning set significantly decreased to chance levels when presented with a vertical separation of six inches between the cue and the site of reward. McDowell and Brown (5) reported significant intraproblem learning, but no interproblem learning, by monkeys tested on peripheral cue learning set with a horizontal-parallel separation of 3.375 inches between the relevant stimuli and the site of food reward. McDowell (4), testing monkeys for transfer of a simple learned discrimination along a horizontal-parallel peripheral cue gradient, noted a direct relationship between error scores and amount of separation between the relevant cue and site of food reward. On the other hand, Brown and Carr (1) report that peripherally placed incidental stimuli take on the sign of the primary stimuli even when the horizontal-perpendicular displacement of the incidental stimuli was six inches from the primary stimuli.

As a result of the Brown and Carr (1) findings, it was hypothesized that the rhesus monkey should also discriminate relevant stimuli at horizontal-perpendicular displacements from identical stimuli placed over the baited foodwells. Also, a *spatial gradient of effect* should occur with the magnitude of the separation of the stimuli from the site of reward being directly related to the number of trials taken to reach criterion and to the error scores as well.

B. Method

1. *Subjects*

Nine normal young adult male rhesus monkeys randomly divided into three groups of three *S*s each were employed in this study. The *S*s had received

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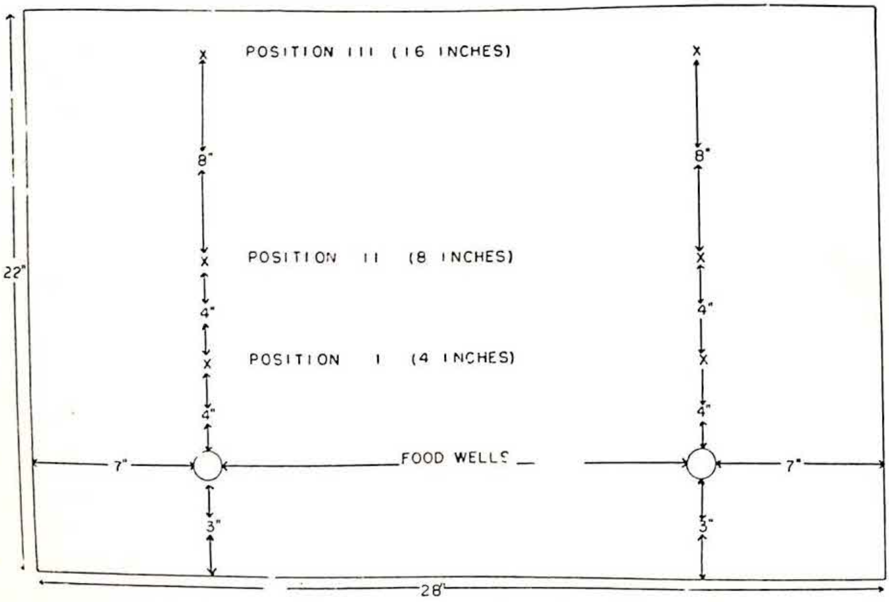
extensive training on discrimination problems *per se,* but had never encountered problems dealing with a separation between the relevant stimuli and the site of reward.

2. *Apparatus*

The *S*s were tested in a modified version of the Wisconsin General Testing Apparatus. An unpainted wooden tray measuring 28 x 22 x ¾ inches with two food wells seven inches from each end and three inches from the front of the tray was employed in this experiment. Two identical grey circular wooden discs measuring 3-⅓ inches in diameter and ¾ inches in depth were placed over the baited food wells and the relevant stimuli were placed directly behind the food wells at distances of 4, 8, and 16 inches (see Figure 1).



PERPENDICULAR PERIPHERAL CUE TESTING BOARD

FIGURE 1
SCHEMATIC DIAGRAM OF TEST TRAY

Three sets of stimulus-objects were employed as the discriminanda. One set was based upon a size discrimination, the second set upon a shape discrimination, and the third set upon a color discrimination. The size discrimination consisted of two green squares. The larger square measured 2-½ x 2-½ x ¾ inches and the smaller square 1-½ x 1-½ x ¾ inches. The shape discrimination consisted of a circular disc and a square. The disc had a diameter of 1-½ inches and a depth of ¾ inches and the dimensions of the square were

1-½ x 1-½ x ¾ inches. The color discrimination consisted of two semicircular discs measuring two inches in diameter and ¾ inches in depth. One was painted yellow and the other blue.

3. *Procedure*

The two grey stimulus objects were placed over the food wells and one of the three sets of relevant stimulus objects was placed at either 4, 8, or 16 inches behind the grey blocks. The *S*s were tested to a criterion of eight correct out of 10 responses.

TABLE 1
SCHEMATIC DIAGRAM OF GRECO-LATIN SQUARE

	Positions		
	4"	8"	16"
Day 1	Group I size	Group II shape	Group III color
Day 2	Group II size	Group III size	Group I shape
Day 3	Group III size	Group I color	Group II size

The Greco-Latin square (8) shown in Table 1 was so constructed that each group of three *S*s received a different set of relevant stimuli at a different position on each of the three days of testing.

C. RESULTS

Figure 2 shows the mean responses to criterion made by all *S*s in terms of the relevant peripheral stimuli for each of the three distances from the site of reward. The results of the analysis of variance applicable to the Greco-Latin square employed demonstrate that the number of trials to reach criterion differed significantly beyond the .001 level for the three different positions of the discriminable stimuli. Inspection of Figure 2 shows that there is a direct relation between the number of trials to criterion and the distance of the relevant stimuli from the site of reward with the number of trials to criterion increasing as the separation between the site of reward and the relevant stimuli becomes greater. No significant differences were found in order of presentation, in learning over days, or in the type of discrimination, i. e., size, shape, or color.

Figure 3 presents the derived exponential function of the results of the trials to criterion at the three horizontal separations. The equation for the curve is (2, 132-135):

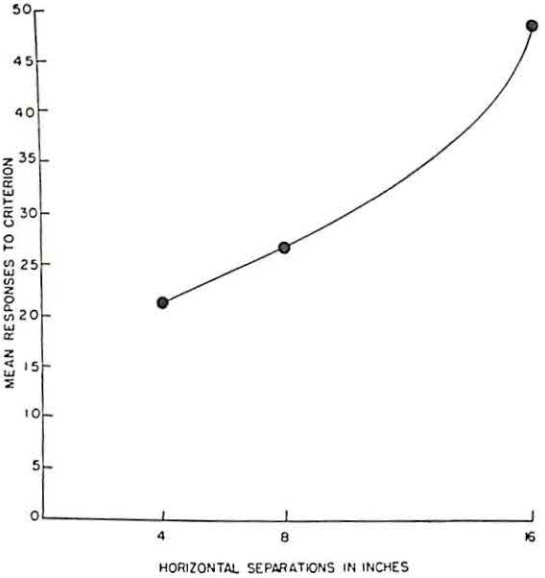


FIGURE 2
Mean Responses to Criterion for the Three Distances From the Site of Reward

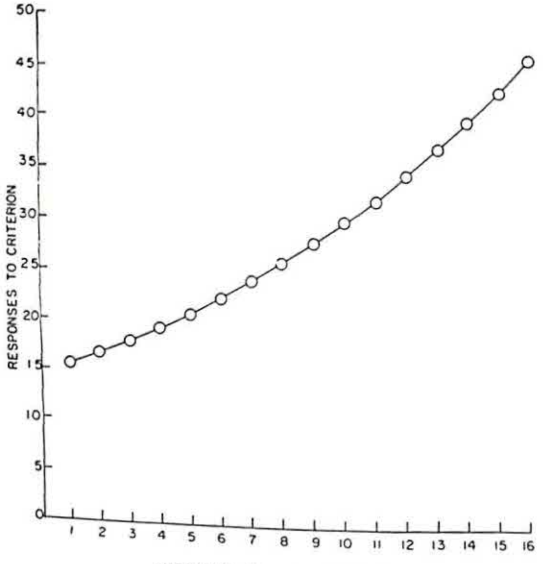


FIGURE 3
The Derived Exponential Function of the Results of Trials to Criterion at the Three Horizontal Separations

$$\log \widetilde{Y} = 1.604 + .0308\ X$$

or

$$Y = 14.47\ (10)^{.0308\ X}$$

Inspection of Figure 3 shows the exponential increase in the number of trials to criterion as the distance between the site of reward and the relevant stimuli is increased.

Figure 4 shows the mean errors made by all *S*s to reach criterion at each of the three horizontal separations. The analysis of the error scores serves to demonstrate a significant difference in the number of errors at each of the three positions beyond the .01 level. Again no significant differences in the order of presentation, learning over days, or type of discrimination were found in the analysis of the error scores.

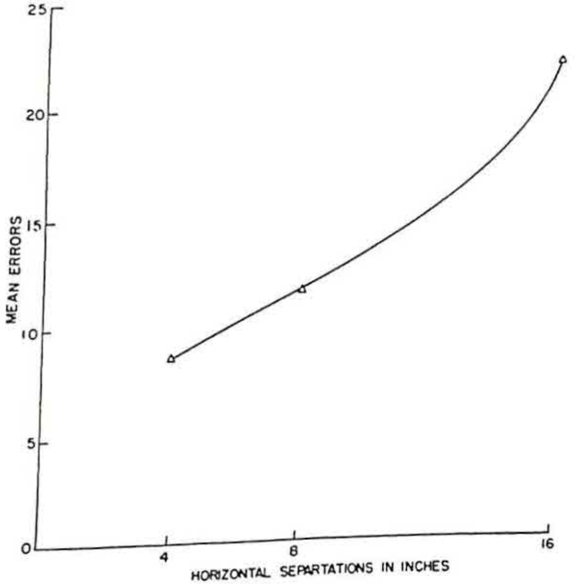


FIGURE 4

Mean Errors to Criterion at Each of the Three Horizontal Separations

D. Discussion

The results of this experiment indicate that the rhesus monkey is able to solve problems in which the discriminable objects are horizontally separated from the site of reward. There is a direct exponential relationship between both the number of trials to reach criterion or the error scores and the horizontal separation between the relevant stimuli and the site of reward. This demonstrates that a greater number of trials is needed to reach criterion and more errors are made in reaching criterion as the horizontal separation between the relevant stimuli and the site of reward is increased.

In terms of contiguity theory (7), the peripherally placed stimuli were "received" by the organism with that one most proximate to the baited food well taking on a "positive valence," according to a *spatial gradient of effect*. Thus the stimuli which are "received" by the *S* form associations with the site of reward.

Since no significant differences between the types of discrimination, i.e., size, shape, or color, were found, it would appear that these types of discrimination have little or no effect upon the *S*s in their association of horizontally separated stimuli with the site of reward.

E. SUMMARY

Nine normal young adult male rhesus monkeys were randomly divided into three groups of three *S*s each. They were tested to a criterion of eight out of 10 correct responses on problems which required them to solve one of three types of discrimination in which the relevant stimuli were horizontally separated at a distance of either 4, 8, or 16 inches from the site of reward.

The results demonstrated that a greater number of trials were required to reach criterion and more errors were made in reaching criterion as the horizontal separation of the relevant stimuli and the site of reward is increased. The type of discrimination, i.e., size, shape, or color, did not seem to have any effect upon their efficiency of performance.

The results are interpreted in terms of a *spatial gradient of effect* in which the stimuli which are most proximate to the site of reward take on a "positive valence" and the degree of "positive valence" decreases as the separation of the relevant stimuli and the site of reward is increased.

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PROBLEM-SOLVING BEHAVIOR OF PRESCHOOL CHILDREN IN A SPONTANEOUS SETTING*

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A. Introduction

The classical conception of mental ability in terms of mental age assumes the distribution of each age group to fall into a normal curve. For instance, a mental age of 5 years and 0 months would fall at the median of a large sample of chronologically five-year-olds in terms of scores achieved on an intelligence measure based on an age scale such as the Stanford-Binet. In the past two decades this concept has been qualified with the consideration of socio-economic factors which tend to distort this picture.

Recently, further attacks on the classical concept of mental age have been reported. Pasamanick and Knobloch (3) report that: "The curve drawn from the distribution of adaptive behavior quotients on approximately 1000 children examined at 40 weeks of age forces us to the conclusion that intellectual status and potential are not quite as normally distributed as intelligence quotient scores later in life would indicate."

They found a relatively low incidence of defective borderline and dull normal groups with a sharp rise in the average range. This distribution fell into a *J*-curve rather than a normal curve.

This approach tends to support the concept held by others that quantitative and qualitative differences in children's and adults' intelligence are primarily experiential rather than actual differences (1, 2, 4).

B. The Problem

In a spontaneous setting, where preschool children are free to use their abilities to solve problems that arise in "real life" situations, it is assumed that the test of these two approaches would be most critical. If the classical concept is accurate, the children with the highest mental age should be able to attempt more effective solutions than the lower mental age children. However, if the "experiential" approach is valid then it would be reasonable that the higher chronological age children should be able to attempt more effective solutions than the lower chronological age children.

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C. METHOD

1. *The Sample*

The sample was selected from a population of 95 preschool children enrolled in a nursery school at a local military installation. They were homogeneous in terms of socio-economic status. The sample consisted of nine children: three *S*s were of ages 3 years and 0 months to 3 years and 4 months, three *S*s were of ages 4 years and 2 months to 4 years and 9 months, and three *S*s were of ages 5 years and 6 months to 5 years and 10 months. Thus there were three 3-year-olds, three 4-year-olds, and three 5-year-olds. These children were selected on the basis of an achievement test administered to the entire nursery school population, so that each sample group contained one high, one average, and one low scorer, as compared to age mates.

2. *Procedure*

1. Each child's spontaneous behavior was observed, and *all* behavior was recorded for one complete school week for each child.
2. From these observations, the problems faced and the attempted solutions were culled out for each child and each problem and response was recorded. Ten problems and their attempted solutions were selected for each child according to the clarity of problem and solution.
3. Each group of responses for each problem was then classified on a five-point scale with the following weights:

(*1*) *Preliminary random response.*

This refers to action following the child's apparent awareness of the problem, but not to action directed toward the solution: for example, name-calling, whining, sulking, crying, looking around helplessly, becoming limp, gesturing toward adults, and screaming. Such behaviors carry an impression of future activity that may not lead to solution of the problem.

(*2*) *Exploration of the problem and trial or approximation.*

This includes such action as questioning adults to gain information, repeating same action toward the problem situation even though the solution may not be nearer as a result, manipulating materials and closely observing as one does so. This behavior might lead to recognition of problems needing solution.

(*3*) *Modification of attempts toward the problem.*

This includes recognized changes in efforts in the direction of the incident, rationalization following attempts, bargaining or threatening, accepting assistance which was not requested, and withdrawal from the situation after trial.

(4) *Persistent action toward the problem incident.*

This includes prolonged behavior toward it with modified attempts at solution, continuous action despite intervention or interruption, continuous action toward the problem situation followed by requests for assistance, rejection of offered assistance and sustained effort. Finally, it might include solution but not necessarily so.

(5) *Hypothesizing and testing.*

This grouping or degree of responsive behavior approximates most closely the type of problem solving readily identifiable as recognizing the problem. Making choices from the testing, and evaluating them in light of the testing, and lastly, choosing one of these in approaching the solution of the problem.

4. The Stanford-Binet Intelligence Test, Form *L*, was administered to each subject.

5. The t-test of significance was used to analyze the differences in sophistication of response.[1]

D. RESULTS

1. *Chronological Age*

Table 1 contains a summary of the data including the total weighted score (ΣX), the mean weighted score (χ), the number of responses (N), the standard deviation (σ), and the standard error of mean (*SE*).

TABLE 1

SUMMARY OF DATA FOR PROBLEM-SOLVING RESPONSES

Age group	ΣX	χ	N	σ	*SE*
5	354	3.4	104	1.1	.11
4	331	3.1	106	1.2	.12
3	218	2.9	76	1.3	.15

Table 2 shows the results of the t-test of significance among the three age groups indicating that sophistication of response does differ significantly with age at the .05 level of confidence between the fours and the fives and at the .01 level of confidence between the threes and the fives. Although only a trend is indicated between the threes and fours, the trend does fit the pattern.

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[1] This concept, sophistication of response, refers to the five-point scale indicated above: the greater the weight given a response, the greater its sophistication.

TABLE 2
THE *t*-TEST OF SIGNIFICANCE OF MEAN PROBLEM-SOLVING RESPONSES AMONG THE THREE AGE GROUPS

Comparisons	t	P
Threes vs. Fours	1.18	—
Fours vs. Fives	2.14	.05
Threes vs. Fives	2.94	.01

2. *Mental Age*

To test whether or not the above effect was due to mental age rather than chronological age, the data was reshuffled according to mental age. As a result, the data for three children changed groups. This entailed one-third of the data. The mean mental age for the reshuffled groups were 5 years and 7 months, 4 years and 9 months, and 3 years and 9 months.

Table 3 contains the summary of the data when regrouped according to mental age.

TABLE 3
SUMMARY OF DATA FOR PROBLEM-SOLVING RESPONSES FOR THE GROUPS WHEN REGROUPED ACCORDING TO MENTAL AGE

Age group	ΣX	χ	N	σ	*SE*
5	328	3.2	101	1.1	.11
4	302	3.2	95	1.0	.11
3	274	3.0	90	0.9	.10

Table 4 shows the results of the *t*-test analysis of problem-solving responses among the groups regrouped according to mental age. No significant relationships are observable.

TABLE 4
t-TEST OF SIGNIFICANCE OF PROBLEM-SOLVING RESPONSES AMONG THE THREE GROUPS WHEN REGROUPED ACCORDING TO MENTAL AGE

Comparisons	t	P
Threes vs. Fours	1.33	—
Fours vs. Fives	0.00	—
Threes vs. Fives	1.33	—

The data in this study tend to indicate that the increase of the sophistication of response to spontaneous problem-solving attempts is related to increase in chronological age rather than increase in mental age.

E. Discussion

The classical concept of intelligence infers an innate, inherited capacity to function intellectually. On this basis so much of the thought regarding humans has been influenced. When evidence was gathered regarding the socio-economic effects on intelligence quotients, the conceptualization of intelligence became modified. It seems evident that this development is a foothold in the changing of the conception of intelligence. For with increased equality in education, increased geographical mobility, increased social mobility, and technological advances in many areas of medical research the differential effects of richer experiences will shed a new light on intelligent behavior.

In the past, environment tended to remain static and constant. The inheritance aspect seemed obvious. Today the dynamic structure of society yields results which confound the picture. Much more work along these lines are necessary, certainly, but the prospects of a new conceptualization of intelligence broaden new horizons.

F. Summary

The critical test of whether differences in intellectual ability is primarily experiential rather than actual could be found in problem-solving behavior of preschool children in a spontaneous setting. This study was designed such that if the primary cause of differences in intellectual ability was actual, the differences in sophistication of response would be found in the data grouped according to mental age rather than chronological age.

If the primary cause of the differences are experiential, the opposite should be found. With all extraneous variables equal, the edge in experience should be with the older children regardless of performance on the intelligence test. In this study the latter was found.

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CALCIUM CONTENT OF THE BRAIN FOLLOWING ELECTRIC SHOCK*

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A. INTRODUCTION

A number of items of indirect evidence, which have been presented elsewhere (5, 6), suggest that calcium plays a role in the physiology of learning. Summarizing briefly, the evidence is in agreement with the following theory: Sustained neural activity and the accompanying decomposition of acetylcholine cause forms (probably ions) of acetic acid to accumulate around neural cell bodies which are active or have just been active. The acetic acid then mobilizes ions of calcium (and possibly salts such as calcium bicarbonate and calcium biphosphate), causing the element to be transported through the veins. As a result, thresholds of synapses around the neural cell bodies are lowered and learning takes place.

The present paper reports an experiment which was exploratory in nature and which was designed to provide a crude delimitation of the loci to which the mobilized calcium is presumably displaced. The authors followed the experimental philosophy of Broadbent (1, p. 309), who contends that an exploratory set of studies should be like the game "Twenty Questions" in that the first study should discriminate between a maximum number of alternatives; therefore, the present study was designed to answer a very simple and broad question regarding the calcium which presumably is mobilized: Is the calcium removed from the entire brain? (Or, conversely, is it displaced only to other neurons or neuroglia, or to other parts of the brain?)

The question stemmed in part from the fact that the total calcium content of the brain decreases with age (7). It seemed possible that the decrease might be partially related to the acquisition of memories.

In order to seek an experimental answer to the question, it was necessary to bring about sustained neural activity; such activity, according to the theory, leads to calcium displacement. On the basis of statements by Bugelski (2, p. 263), Gerard (3), and others, it was assumed that appropriate electrical stimulation of the brain can produce sustained neural activity. There-

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fore, analysis of the brain following electrical stimulation offers an answer to the question under study. If electrical stimulation is followed by the removal of calcium from the entire brain, one might suppose that a similar large-scale displacement occurs in learning. If electrical stimulation is not followed by removal of calcium from the entire brain, one might conclude that the calcium which presumably is displaced in learning is merely moved to a new pattern of locations within the brain.

B. METHOD

1. *Subjects*

The 40 *S*s included 18 naive albino rats from the colony maintained by the Radiation Biophysics Laboratory of the University of Kansas, and 22 naive male and female hooded rats from the authors' colony.

2. *Equipment*

Shocks were produced by a device which was designed and built by O'Loughlin Electronics of Hays, Kansas. Equipment used in the determination of brain calcium included a standard colorimeter and the flame photometer of the University of Kansas chemistry department.

3. *Procedure*

*S*s were paired on the basis of weight and litter of origin. The experimental member of each pair was given 200 shocks through electrodes on the ears. Each shock was of approximately .008 amp. and 320 v., DC, lasting .1 sec. (Such shocks produce minimal convulsive behavior.) *S* received 25 shocks at 30-sec. intervals, then was returned to its cage for a delay of 45 to 60 min., after which the next volley of shocks was begun. After each experimental *S* had received its quota of shocks, it and the corresponding control *S* (which had never been shocked) were killed with chloroform. An attempt was made to equalize the activity of experimental and control *S*s during the chloroforming, since motor activity exerts a temporary influence on the calcium content of the lower brain centers (7). As soon as each *S* had been sacrificed, its brain was removed, weighed, and refrigerated. Later the total calcium content of each brain was determined. The interval between the refrigeration of a pair of brains and the calcium determination ranged from one to 12 days.

C. RESULTS

The mean calcium content of the experimental *S*s' brains was 9.29, and the control mean was 8.96. (These means are expressed in mg. of calcium per 100 g. of fresh brain.) According to the *t* test for correlated measures, the two means do not differ significantly ($t = 1.01$). Therefore, the data indicate (within the limits of instrumental accuracy) that calcium is not removed from the entire brain following electrical stimulation.

D. DISCUSSION

Although the results of the present study suggest that the hypothesized calcium displacement is limited to transfers between loci within the brain, the results also indicate the need for much finer delimitations. Additional studies, focused upon specific structures and areas within the brain, seem desirable. In addition to the possibility that they might give meaning to the phrase "locus of learning," such studies might constitute a more crucial test of the theory that calcium displacement does occur. (It is possible, of course, to use the data reported here to cast doubt upon that theory.)

Additional studies would involve formidable technical difficulties. Perhaps some of these difficulties might be overcome in a manner suggested by Hilgard (4, p. 482) in his discussion of the general question of the physiology of learning. He advised that a ". . . simpler organism like the amblystoma should be chosen, in which the nervous elements are few enough to be under direct inspection with modern techniques."

E. SUMMARY

This study was related to the theory that learning is a concomitant of the displacement of calcium salts from neural nuclei as a by-product of sustained neural activity, and sought to answer the question of whether calcium is removed from the entire brain or is merely displaced to different neurons or neuroglia. In an effort to sustain neural activity artifically, 20 rats were given 200 electric convulsive shocks. Then their entire brains were compared with those of 20 control animals. No significant difference in calcium content was found. It was suggested, therefore, that calcium is not removed from the entire brain as a result of sustained neural activity.

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SUBCULTURAL VARIATIONS IN VERBAL AND PERFORMANCE ABILITY AT THE ELEMENTARY SCHOOL LEVEL*

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A. Introduction

Numerous studies have been made of the differences in intellectual ability displayed by various minority groups in the United States. Since 1920, various investigations into the intelligence of Jewish, Irish, and Italian American children have been carried out and reported by Murdoch, (1920), Bere (1924), Feingold (1924), Hughes (1928), Goodenough (1926), Hirsch (1926) and others.

Initially, these investigators believed that the tests they administered were equally valid for all groups and that the differences they found were therefore due to either acquired or inherited intellectual inferiority. Subsequently, researchers became aware that differences in intelligence may result from foreign birth, language factors, or varying socio-economic backgrounds. As a matter of fact, Eells found that it was the socio-economic background, rather than cultural affiliation, which had the greater influence on intelligence test scores (Eells, David, Havighurst, Herrick, and Tyler, 1951).

Despite the significant findings of the various researchers mentioned above, many clinical psychologists still ascribe differences in psychometric patterns to pathological causes with a disregard of the socio-economic differences among the intelligence test subjects. Little heed is thus being paid to the possibility that test score differences and different test scatter may be due to variations in the cultural background of the samples which may be equated with differences in socio-economic background, nativity, and bilingualism. For instance, the Roberts and Robinson study (1952) shows different ability patterns in Negroes and whites.

Little is known, as yet, about the effect of socio-economic background, nativity, and bilingualism upon psychological and social pathology. Yet, research studies do indicate that there are differences in gestures (Efron, 1941), personality traits, and attitudes among individuals coming from

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different subcultures. We thus find that differences in the subcultures of the Irish and Italians reflect themselves in different schizophrenic symptoms (Singer and Opler, 1956). Indeed, frequently, the groups which may appear to exhibit similar psychological and social pathology (Levinson, 1956/57) may react the way they do for entirely different reasons.

B. PROBLEM

Our hypothesis is that different subcultures produce different constellations of intelligence test responses. Furthermore, we believe that the more closely subcultures resemble each other, the more similar will be their psychometric patterns. We feel that ethnic groups which become more acculturalized, in turn, produce psychometric patterns similar to each other and to the norms of the American people.

We have adopted the definition (Eells *et al.,* 1951) of an ethnic group as being "a foreign culture group of sufficient size and cultural cohesiveness as to constitute a separate subculture in the community, recognized as such both by the ethnic group in question and by the community at large." We hypothesized that both the family and the school transmit the psychological characteristics peculiar to each group. In order to see how these subcultural forces express themselves in America, we must compare groups which clearly identify themselves as members of a subcultural group and send their children to schools which emphasize these ethnic differences. The school, it must be recalled here, is an important agent in perpetuating and reinforcing those abilities thought important in a particular subculture. In this connection, one may recall a study of Fillela (1957) indicating that even a mere following of a certain curriculum may influence the pattern of abilities. Students who have received largely technical training may have a higher loading on quantitative and spatial factors, whereas academic students may have a higher loading on the verbal factor. As a case in point, we decided to study the WISC psychometric patterns of Jewish, Irish, and Italian children.

C. METHOD

1. *Procedure*

Our subjects were selected from three all-day religious schools, a Catholic parochial school attended predominantly by Irish Catholics, a Catholic parochial school attended predominantly by Italian Catholic children, and a day (Yeshiva) elementary school, attended predominantly by Jewish children from a traditional background.

2. *Criteria for Selection of Subjects*

Our criteria for selection of subjects were as follows: (*a*) Native born attending 4, 5, and 6th grade of the selected schools. (*b*) The subjects were to be aware of their origin and possessed of ethnic consciousness. (*c*) Boys only. We did not want sex differences to act as an artifact in our study. Levinson (1959), for example, found that the psychometric patterns of Jewish pre-school boys of traditional background are different than that of girls of the same background. (*d*) Age 10-13. (*e*) Each subject to be matched for total *WISC IQ* with his counterpart in the other two groups.

3. *Selection of Subjects*

a. Jewish. In selecting the Jewish groups, we tried as far as possible to select children for whom Jewishness was all encompassing. In this connection, we must remember that, by and large, the traditional Jew is more aware of his ethnic ties than any other branch of the Jewish people. To him, intensive Jewish education is the *sine qua non* of Jewish survival. It is the only means of maintaining the national identity. The burden of transmitting the religious and cultural heritage of the Jewish people is placed upon the boys who must learn the "how" and "why" of religious observance and transmit this knowledge to their offspring. The resulting self-image of a boy brought up under these circumstances, with its consequent ego ideals indigent to the group, produces different social, cultural, and educational values and consequently a different psychometric pattern. For this reason, our subjects were selected from a traditional day school.

b. Irish and Italian. According to Rossi and Rossi (1951, p. 181), ethnicity is to a large extent a determinant of parochial school attendance. Furthermore, the upper-mobile groups among the Italian and Irish will tend to send their children to parochial schools which are believed to give a better education. It is also a hall mark of distinction to have been graduated from a parochial school. Since the academic standards of the parochial school are considered very high, a child who is able to maintain himself in such a school feels great pride in this ability.

4. *Limitations*

We do not consider our sample representative of all Jewish, Italian, or Irish children, not even necessarily representative of all children who attend all-day religious schools. We must remember that parents who send their children to parochial schools are not typical of all parents.

They may or may not differ from representatives of their nationality in intelligence, personality traits, and other characteristics. We further do not know what selective factors have been operating in the school itself and why some children remained in the parochial schools and others were transferred to public schools.

D. RESULTS

The full *WISC IQ* for each group was 108.74 with an *SD* of 11.92. The Jewish boys had a Verbal *IQ* of 117.19 with an *SD* of 9.86; a Performance *IQ* of 98.15 with an *SD* of 12.73. The Irish boys had a Verbal *IQ* of 110.91 with an *SD* of 11.72, a Performance *IQ* of 105.30 with an *SD* of 13.75; the Italian boys had a Verbal *IQ* of 110.06, with an *SD* of 13.65, and a Performance *IQ* of 105.43, with an *SD* of 12.71. The mean *CA* of the Jewish children was 11.51. The mean *CA* of the Irish children was 10.95 and the mean *CA* of the Italian children was 11.63.

1. *Parental Country of Origin*

As can be noted from Table 1 the nativity of the parents and the language spoken at home varied with the different groups. The Italians had more native born parents and the Irish had fewer parents speaking a language other than English than any other group. The Jewish children reported that over 68 per cent of their parents were born abroad and over 76 per cent had parents who spoke more than one language at home. A question may be raised at this point as to whether the subcultural pattern we are discussing here is really the same for the Jews since unlike the Italians or Irish, over 68 per cent of their parents came from seven European countries, whereas the Irish and Italian have more parents who have been born in this country, and in a sense have absorbed the culture of this country.

TABLE 1
BILINGUALISM AND NATIVITY OF THE PARENTS OF THE JEWISH, IRISH AND ITALIAN BOYS

		Jewish		Irish		Italian	
		N	%	N	%	N	%
Bilingualism		36	76.6	2	4.26	20	42.55
Native born	Fathers	11	23.4	37	78.7	40	85.10
	Mothers	11	23.4	35	74.5	44	93.6
	Not reported	4	8.5	5	10.6	2	4.3

The fact that three times as many parents of the Jewish subjects, as compared with the Irish and Italian, were foreign born Americans does not, in the opinion of this author, invalidate the results of this study. This writer believes that the Jewish traditional values are transcendental and will have the same influence on the life of the strictly orthodox Jew regardless of where he lives or for how long. To the traditional Jew who becomes so deeply immersed in the philosophy of Judaism that it becomes a part of his being, the values of traditional Judaism are all encompassing and not easily affected or disturbed by acculturation.

2. *Socio-economic differences*

It is well known that socio-economic background has a positive relationship with *IQ*. Perhaps the major test of the validity of our study rests upon analysis of the socio-economic backgrounds in our sample and their effect, if any, upon the *IQ*s. Furthermore, since research (Seashore, 1951) indicates that on the *WISC* there is a statistically significant difference between the verbal and performance tasks for professional as against non-professional groups, this area had to be considered so as not to mistake the artifact of test standardization for real differences between subcultural groups. Therefore, before we could proceed with our study this artifact had to be studied. It is a truism, of course that socio-economic differences in one group may signify large cultural differences which may not all exist in another group.

Table 2 shows the mean *WISC* Full, Verbal, and Performance *IQ*s according to the father's occupation. (In the few cases where the father was deceased, the mother's current occupation was indicated.) We may note that the Jewish boys who had more foreign born parents had more parents in the professional and semi-professional occupations. Peculiarly enough these findings, somehow, contradict the statement of Warner and Srole (1945) that the ethnic group which has been in the country longest "has an occupational distribution more heavily weighted in the professional and proprietary class and in the clerical class than those groups of more recent origin." We divided the occupational distributions for each group into three categories as follows: *Category 1* consisted of (*a*) professional, technical and kindred workers, and (*b*) managers, officials and proprietors except farms; *Category 2* consisted of (*a*) clerical and kindred workers, and (*b*) sales workers; *Category 3* consisted of (*a*) craftsmen, foremen, and kindred workers, (*b*) operatives and kindred workers, and (*c*) service workers except private household. There were no statistically significant differences in total *WISC* *IQ*s among occupational groupings for all categories. It appears, therefore, that socio-economic background had no influence on *IQ*s in our samplings. In fact some of the groups which, according to previous research findings

TABLE 2

MEAN *WISC* FULL, VERBAL, AND PERFORMANCE SCALE *IQ*s OF THE JEWISH, IRISH, AND ITALIAN CHILDREN ACCORDING TO FATHER'S OCCUPATIONS

	Jewish				Irish				Italian			
	N	WISC Full	WISC Verbal	WISC Perf.	N	WISC Full	WISC Verbal	WISC Perf.	N	WISC Full	WISC Verbal	WISC Perf.
Professional, technical and kindred workers	8	104.88	114.50	95.50	1	121	126	111	4	107.75	104.00	110.5
Managers, officials and proprietors, except farm	8	111.38	121.13	98.50	3	104.33	109.67	97.3	3	108.33	102.00	115.33
Clerical and kindred workers	9	109.67	117.89	99.67	14	107.29	110.29	102.29	6	109.83	113.17	104.33
Sales workers	5	103.4	115.00	91.60	12	111.00	114.08	106.67	9	114.89	115.11	111.67
Craftsmen, foremen and kindred workers	14	111.14	116.93	101.71	5	117.00	113.60	117.60	15	103.73	107.93	97.67
Operatives and kindred workers	3	106.33	116.67	94	10	102.50	106.2	99.6	5	108.00	109.00	104.60
Service workers except private household					2	117.50	107.50	125	5	113.20	114.40	109.60

(Eells, 1951), should have had the lowest *IQ*s compared well with those in more favorable economic circumstances. Whatever other factors may have affected the psychometric pattern in our groups, socio-economic differences seemed to exert the least or no influence. This may be due to (*a*) the upper-mobility strivings of the parents who send their children to these schools (Rossi and Rossi, 1957) and thus possibly also provide a better environment, or (*b*) it may also be due to the fact that within each of the three groups the subjects were matched for *IQ*. This restricted the range and thus would tend to reduce the correlation. We also considered the possibility, strictly an hypothetical one, that a selection may have occurred in the parochial school, if children from poorer homes who cannot master the work are eliminated, while the inferior scholar whose parents paid their fees and are somewhat influential, is retained in the school. We discussed this with the school officials and were informed that ability to pay tuition fees was not a factor in the school's decision to retain or drop a pupil.

Table 3 indicates that in all three groups the verbal scores are higher than the performance scores. Furthermore, that the intra-group differences between the verbal and performance scores are statistically significant for the Irish and Jewish children, the Jewish group having a statistically significantly higher verbal and statistically significantly lower performance score than any other group. We can also note that the inter-group differences between verbal and performance scores are statistically significant for all groups.

3. *Differences between Jewish and Italian Boys*

Table 4 indicates that the Jewish boys have significantly higher scores in *WISC* verbal scale and in the following *WISC* verbal subtests: Information, Comprehension, Arithmetic, and Similarities. The Italian children, on the other hand, have significantly higher scores on *WISC* performance scale and the following *WISC* performance subtests: Picture Completion, Picture Arrangement, Block Design.

4. *Differences between Jewish and Irish Boys*

An analysis of Table 5 indicates that the Jewish boys have significantly higher scores than the Irish boys on *WISC* verbal scale and the *WISC* verbal subtests: Comprehension, Similarities. The Irish boys, on the other hand, have significantly higher scores on the *WISC* Performance scales and on the following *WISC* performance subtests: Picture Completion and Block Design.

TABLE 3

SIGNIFICANCE OF THE DIFFERENCES BETWEEN THE MEANS OF THE *WISC* VERBAL AND *WISC* PERFORMANCE SCALES OF THE JEWISH, IRISH, AND ITALIAN BOYS

		Jewish				Irish				Italian			
	WISC Perf.	WISC Verbal	Diff.	SDm	t	WISC Verbal	Diff.	SDm	t	WISC Verbal	Diff.	SDm	t
Jewish	98.15	117.19	19.04	2.35	8.10**	110.91	12.76	1.31	—9.74**	110.06	11.91	1.34	=8.89**
Irish	105.30	117.19	11.89	1.20	≡9.91**	110.91	5.61	2.59	2.16*	110.06	4.76	1.45	=3.28**
Italian	105.43	117.19	11.76	1.36	≡8.65**	110.91	5.48	1.50	—3.65**	110.06	4.63	2.62	1.77

* .05 level of confidence.
**— .01 level of confidence.
— difference in favor of Irish boys.
= difference in favor of Italian boys.
≡ difference in favor of Jewish boys.

TABLE 4

SIGNIFICANCE OF THE DIFFERENCES BETWEEN THE MEANS OF THE TESTS OF THE JEWISH AND ITALIAN BOYS

	Jewish		Italian				
	N	Mean	N	Mean	Diff.	SEm	t
WISC Verbal	47	117.19	47	110.06	7.13	1.38	5.17**
WISC Performance	47	98.15	47	105.43	7.28	1.41	—5.16**
WISC Verbal Subtests							
Information	47	12.53	47	11.34	1.19	.47	2.53*
Comprehension	47	14.19	47	12.72	1.47	.43	3.42**
Arithmetic	47	12.57	47	11.32	1.25	.49	2.55*
Similarities	47	12.40	46	10.83	1.57	.57	2.75**
Vocabulary	47	12.23	47	11.79	.44	.49	.90
WISC Performance Subtests							
Picture Completion	47	9.62	47	11.17	1.55	.60	—2.58*
Picture Arrangement	47	10.11	47	11.19	1.08	.45	—2.40*
Block Design	46	9.72	47	10.85	1.13	.46	—2.46*
Object Assembly	47	10.28	47	10.19	.09	.67	.13
Coding	47	10.43	45	10.87	.44	.67	— .66

* .05 level of confidence.
** .01 level of confidence.
A minus sign indicates a difference in favor of the Italian boys.

TABLE 5

SIGNIFICANCE OF THE DIFFERENCES BETWEEN THE MEANS OF THE TESTS OF THE JEWISH AND IRISH BOYS

	Jewish		Irish				
	N	Mean	N	Mean	Diff.	SEm	t
WISC Verbal	47	117.19	47	110.91	6.28	1.00	6.28**
WISC Performance	47	98.15	47	105.30	7.15	1.52	—4.70**
WISC Verbal Subtests							
Information	47	12.53	47	12.21	.32	.56	.57
Comprehension	47	14.19	47	12.45	1.74	.49	3.56**
Arithmetic	47	12.57	47	11.81	.76	.53	1.43
Similarities	47	12.40	46	10.93	1.47	.46	3.20**
Vocabulary	47	12.23	46	12.09	.14	.43	.33
WISC Performance Subtests							
Picture Completion	47	9.62	47	11.49	1.87	.62	—3.02**
Picture Arrangement	47	10.11	47	11.04	.93	.51	—1.82
Block Design	46	9.72	47	10.79	1.07	.44	—2.43**
Object Assembly	47	10.28	45	10.31	.03	.68	— .04
Coding	47	10.43	47	9.72	.71	.51	1.39

* .05 level of confidence.
** .01 level of confidence.
A minus sign indicates a difference in favor of the Irish boys.

5. *Differences between Irish and Italian Boys*

On the other hand, an analysis of the differences between the means of the Irish and Italian children indicates that the Italian children have significantly higher scores in Coding.

TABLE 6
SIGNIFICANCE OF THE DIFFERENCES BETWEEN THE MEANS OF THE TESTS OF THE IRISH AND ITALIAN BOYS

	Irish		Italian				
	N	Mean	N	Mean	Diff.	SEm	t
WISC Verbal	47	110.91	47	110.06	.85	1.70	.50
WISC Performance	47	105.30	47	105.43	.13	1.65	— .08
WISC Verbal Subtests							
Information	47	12.21	47	11.34	.87	.56	1.55
Comprehension	47	12.45	47	12.72	.27	.55	—0.49
Arithmetic	47	11.81	47	11.32	.49	.53	.92
Similarities	46	10.93	46	10.83	.10	.55	.18
Vocabulary	46	12.09	47	11.79	.30	.47	.64
WISC Performance Subtests							
Picture Completion	47	11.49	47	11.17	.32	.54	.59
Picture Arrangement	47	11.04	47	11.19	.15	.54	.28
Block Design	47	10.79	47	10.85	.06	.43	— .14
Object Assembly	45	10.31	47	10.19	.12	.47	.26
Coding	47	9.72	45	10.87	1.15	.57	—2.02*

* .05 level of confidence.
** .01 level of confidence.
A minus sign indicates a difference in favor of the Italian boys.

E. DISCUSSION

The different *WISC* patterns of the Jewish children, as compared with the Irish and Italian raises serious problems. Does this mean that an earlier differentiation of abilities occurs in the Jewish group than in the Irish or Italian? Does this also mean that if the organization of abilities is different in these various groups that their personality traits will also differ? If so, are these differences merely superficial? It is hard to answer these questions at this point since the psychological meaning of the subscores is largely unknown (Guilford, 1956), even though we do have some evidence which would indicate that individuals with varying life experiences perform differently on the same tests (Anastasi 1948; Levinson, 1958).

A related problem is whether these subtests are equally meaningful for these various groups. The writer believes that the functions of the tests change with different subcultures. Although children coming from deviant subcultures do achieve identical *IQ* scores based on their passing similar tasks, it can hardly be denied that their organization of abilities is nevertheless different. This is due to the fact that the significance of the task and its meaning is not the same for these subjects.

Our findings show that the psychometric patterns of the Jewish children differ drastically from those of the Irish and Italian. This may indicate that as acculturation proceeds, the intelligence patterns of the subcultures longest exposed to American influences such as the Irish and Italian tend to become more and more similar. The possibility must also be entertained that different subcultural groups tend to solve school problems in different ways placing emphasis on different areas of learning. Just as we may speak of individuals who have an "abstract" or "concrete" orientation, possibly we may say that the same condition exists for our subcultures and is reflected in the parochial schools they maintain. The fact that the Jewish day (Yeshiva) schools place so much stress on verbal abilities is discernible, in this writer's opinion, in the significant elevation of verbal scores among the subjects from this sector. One of the important factors may be that the hours are longer in the Jewish parochial schools which maintain a double program, one in English and the other in Hebrew, which may either require or develop additional language skills among these students. The long school day, coupled with additional hours of homework (Levinson, 1959b), leaves little time for extra-curricular activities.

Research indicates that there are no statistically significant differences between verbal and performance scores of the preschool Jewish child (Levinson, 1959a). Apparently, then, the difference between verbal and performance intelligence found here, if confirmed by further investigations, is due to the influence of the school in stressing Jewish cultural values.

Two significant questions which arose from the facts developed in this study, are: Can the verbal score be considered as valid for the Jewish sample, so that the lowering of the performance score must be further explained? Or should one consider the performance score accurate for the Jewish group and seek an explanation for the elevation of the verbal score? This is currently being investigated.

F. SUMMARY

The *WISC* psychometric patterns of native born Jewish, Irish, and Italian boys matched for full *WISC IQ* and attending fourth, fifth, and sixth grades of all-day religious schools were analyzed. There were statistically significant differences among the verbal and performance scales, as well as certain subtests for the three groups.

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CHILDREN'S REPETITION CHOICES IN AN INTELLECTUAL ACHIEVEMENT SITUATION FOLLOWING SUCCESS AND FAILURE*

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A. INTRODUCTION

The everyday learning situations confronting young children are varied and numerous. For any child, from time to time these range from problems which he can handle readily and with little effort, to tasks requiring maximum utilization of his intellectual capacities. In the latter instances successful solutions are often contingent on, not only the child's intellectual abilities, but also upon his motivation for task-mastery. Achievement motivation and the desire for task-mastery are important and integral aspects of young children's intellectual growth. Some children, it appears, develop a strong desire for task-mastery; others do not. When temporary frustrations and failures in learning situations arise, some children return to these situations and attempt to master them, while other children assiduously avoid such experiences. The habitual use of failure-avoidant *vs.* task-oriented behavior should eventually affect children's general intellectual development. The consistent avoidance of previously-failed tasks lessens the possibility of developing new and more effective methods of task solution for these and other similar problems. Also, to the degree that failure-avoidant behaviors decrease the likelihood of successful attainments, these behaviors may ultimately produce lowered achievement motivation *per se*. The failure-avoidant child may thus, as the result of poorly developed attainment methods and/or lowered motivation, eventually experience difficulty in employing his talents and abilities effectively and successfully. In contrast, the child with a strong task-mastery orientation should, given reasonable intellectual capacities, develop relatively greater problem-solving skills, and greater freedom to maximally use his abilities.

How and when does the motivation for intellectual task-mastery develop?

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[1] This study was one of several preliminary studies of a larger research project, "Parents as identification models and reinforcers of children's achievement development," supported in part by a special grant from the National Institute of Mental Health, United States Public Health Service.

Child psychologists have observed that the behavior of infants and young children is often primarily motivated by a desire for immediate gratification. Most young children have low tolerances for frustration and for the delay of gratification. However, as children mature, they gradually learn to delay gratification, and to tolerate frustration and failure. In the area of intellectual achievement, the desire for task-mastery appears to play a central part in this general development. For most children, the desire to independently master difficult achievement situations appears to acquire intrinsic value with age. Difficult learning situations are faced, frustrations are accepted, and gratifications delayed, when a child anticipates ultimate satisfaction eventuating from his independent achievement efforts.

All children experience frustration and temporary failure in everyday learning situations. When this occurs, children are confronted with the basic choice of subsequently either avoiding or re-entering the same or similar situations. The nature of these choices, as previously discussed, has an important bearing on children's ultimate achievement motivation and performance. Children's repetition choices following success and failure have been studied under controlled experimental conditions by Rosenzweig (2). This research found age to be a factor in such choices; older children more frequently preferred to return to uncompleted or failed tasks than did younger children. This difference was interpreted in terms of the Freudian "pleasure" and "reality" principles. According to Rosenzweig, the younger children's choices reflected a desire for immediate gratification which task completion gave, while the older children were more reality-oriented, i.e., they were more willing to forego the immediate pleasure of repeating a previously-successful experience for the ultimate possibility of mastering a previously-failed task.

The results of Rosenzweig's research are provocative. However, that study left several important developmental questions unanswered. First, while significant age differences were found in the children's repetition choices, the study was not designed to determine when these changes occurred, or whether they were rapid or gradual ones. The ages of the children studied ranged from four and one-half years to 14 and one-half years. The mean chronological age of the children who chose to repeat previously-failed tasks was 11 years and four months; the mean age of the children preferring to return to previously-succeeded tasks, seven years and six months. Whether the increased preferences for the failed task gradually developed with age, or whether this change was an abrupt one developing in pre-adolescence could not be determined by the study. Second, the study failed to analyze sex differences. The possibility that children's repetition choices might be a function of sex as well as age is not unlikely. For example, Winterbottom (3) found that independence training in middle-class homes is begun earlier for boys than for girls. To the degree that independence training may be a precursor of achievement motivation in general and task-mastery motivation in particular, boys might be expected to repeat and attempt to solve previously-failed achievement situations more frequently than girls. Finally, while the Rosenzweig study found significant changes in children's repetition choices with age, the interpretation that these reflected a change from a "pleasure" to a "reality" orientation in the intellectual achievement area was a *post hoc* explanation; no independent measures of these variables were obtained in the study.

The present study had three general aims. Its first objective was to ascertain, using procedures similar to those of the Rosenzweig study, whether age differences in children's repetition choices were discernible before pre-adolescence. Second, the study was designed to evaluate sex differences as well as age differences. Finally, independent measures of selected personality variables likely to be associated with children's repetition choices were assessed.

B. METHOD

1. *Subjects*

The sample of the study was comprised of 59 children from three years to nine years of age. The children came from middle-class families in southwestern Ohio. All families were members of the Fels Research Institute's Longitudinal Study.

The children were divided into two groups. The younger group was comprised of 30 three-, four- and five-year-olds who attended the Fels Experimental Nursery School, and will be referred to as the nursery school group for the remainder of the discussion. The older group was comprised of 29 six-, seven- and eight-year-olds. This group attended the Fels Day Camp in early summer after their regular schools had closed. These older children will be called the early grade school group.

2. *Repetition Choice Experiment*

The repetition choice experiment was administered to the children in individual sessions. Each child was brought from his play group into an experimental room and was seated at a small testing table. The experimenter told the child that he was to be tested to see how well he could solve puzzles. Two seven-piece wooden puzzles were presented the child. One puzzle contained a picture of a bear; the other, a picture of a turtle. Pre-testing indicated that the two puzzles were approximately equal in difficulty. Within each of the two age-groups of children, the temporal order of presentation of the puzzles was randomly determined. Half of the children were presented the bear puzzle first, and half were administered the turtle puzzle first. Similarly, for each age-group, the specific puzzle on which the child failed or succeeded was randomly assigned.

Success and failure was manipulated by the experimenter in the following manner. Each child was told that his performance would be timed, and that he would be allowed one and one-half minutes to complete a puzzle. The experimenter held a stopwatch in his hand and ostensibly timed the child's performance. In all instances, the puzzle that the child was to experience failure on was taken from him when he had five of seven pieces correctly in place. The experimenter told the child his time was up and added, "You didn't finish it in time." When the child was administered the alternate puzzle, he was allowed to finish it, with the experimenter stating immediately following its completion, "You finished that one before your time was up." As soon as the child had attempted to complete both puzzles, the experimenter informed him that time remained for him to work on one of the two puzzles again. The child was asked to choose the puzzle he preferred to work on a second time. His response, his repetition choice, was recorded for subsequent data analysis.

3. *Behavior Ratings*

Aside from the time the children were in the repetition choice experiment, they participated in the regular Fels Institute's Nursery School or Day Camp programs. During these sessions, the children's interactions with their peers and with the adult Nursery School and Day Camp staffs were observed. Two full-time observers made daily-time-sample observations of each child.[2] On the basis of these observations, each observer independently rated the children in respect to a number of social behavior variables. A more detailed description of the rating variables, the rating scales, and inter-rater reliability can be found elsewhere (1). In the present study, six variables were selected as especially relevant to the problem under investigation. These variables were: (*a*) amount of achievement efforts displayed in free-play, (*b*) amount of help seeking from other children, (*c*) amount of help seeking from adults, (*d*) amount of approval seeking from other children, (*e*) amount of approval seeking from adults, and (*f*) readiness of withdrawal in threatening situations.

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[2] The authors are grateful to Mrs. Phyllis Cannon who directed the Fels Nursery School and Day Camp, and to Mrs. Sonya Orleans who served, along with the junior author, as an observer and rater of the children's free-play social behavior.

The ratings of the two observers for each child were averaged for each of the variables, and these scores were employed for all data analyses.

C. RESULTS

1. *Age and Repetition Choices*[3]

The repetition choices of the nursery school children were compared with those of the early grade school children. The obtained chi square was 2.66, $p < .10$, indicating a non-significant trend for the older children to prefer repeating the previously-failed puzzle rather than the successfully-completed one. While this trend was in the same direction found in Rosenzweig's original study, the magnitudes of the relationships obtained in the two studies differed. Rosenzweig's research, employing the same experimental method used in the present investigation, found a highly significant relationship between children's repetition choices and age. The fact that the present investigation was limited to children three through eight years of age while Rosenzweig's research included pre- and early-adolescent children, suggests that the increase in children's preferences for repeating previously-failed experiences begins to develop by early grade-school age, but is likely to continue at least through pre-adolescence. The change in the willingness of normal children to forego immediate success for ultimate task mastery appears to gradually develop with age.

2. *Sex and Repetition Choices*

The repetition choices of the total sample of boys *vs.* girls were compared. A chi square of 6.69, $p < .01$, was obtained. The boys preferred returning to the previously-failed puzzle more frequently than the girls. In the present study, then, sex differences were more pronounced than age differences. The girls more often chose to avoid potential failure and seek satisfaction where they had previously experienced success; the boys were more willing to risk failure in order to ultimately master a task on which they had previously failed.

Interactions of age and sex on the children's repetition choices were also explored. Fisher's exact test was employed for these analyses, and the following results were obtained. First, no significant difference was found between the repetition choices of the nursery school-age boys and girls. Second, in the early grade school group, the boys chose to repeat the previously-failed puzzle much more frequently than the girls ($p < .01$). Third, there was no significant difference in the choices of the nursery school girls *vs.* early grade school girls. Finally, the older boys more often elected to repeat the previously-failed puzzle than did the nursery school boys ($p < .01$). These results indicate that the significant sex difference obtained for the total group of children was primarily due to the fact that changes in repetition choices occurred with age for the *boys* but not for the girls; the boys became more motivated toward task-mastery while the girls did not. The sex difference in repetition choices may have reflected an increased emphasis on achievement *per se* by the boys during early grade school and/or the development of more assertive methods of attempting to attain achievement goals. The ratings of the children's behaviors outside the experimental situation are relevant here.

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[3] A Mann-Whitney *U*-Test was run between the repetition choices and the Stanford-Binet *IQ*s of the total group of children. No statistically significant relationship was found. Intelligence was not a factor in the children's repetition choices.

3. *Free-play Behavior*

Like their repetition choices, the children's six free-play behavior variables were analyzed by age and sex. These analyses provided information for determining whether or not the free-play social behaviors reflected sex and age differences similar to those found in the repetition choice experiment. The Mann-Whitney *U*-Test was employed for all statistical analyses of the free-play data.

In the nursery school-age group of children, no statistically significant sex differences were found. The boys exhibited no more free-play achievement efforts than the girls. Nor were they more or less prone to seek approval or help from others. This latter obtained regardless of whether these overtures were directed toward other children or toward adults. Finally, the nursery school-age boys and girls were equally ready to withdraw from threatening situations. In short, as with the young children's repetition choices, no sex differences were found at this early age.

The free-play behaviors of the early grade school-age children, however, presented a different picture. For these older children, while no sex differences were found in the amount of achievement efforts displayed, other differences were evident. The girls more often sought help from other children than the boys ($p < .01$), and they were also more prone to ask for help from adults ($p < .05$). A similar sex differentiation was found in respect to approval-seeking. The girls sought approval for their achievement efforts from the adult staff more often than the boys ($p < .01$), and there was a trend, though non-significant, for the girls to also seek approval from other children more frequently. Finally, the girls withdrew more readily from threatening situations than the boys ($p < .01$). In general, then, sex differences were not evident in the nursery school-age children's free-play behaviors, but became apparent, like the sex differentiation in repetition choices, by early grade school age.

The results of the free-play data suggest two major conclusions regarding personality attributes associated with sex differences in children's repetition choices following success and failure. First, the greater task mastery orientation with age evidenced by the boys in the repetition choice experiment was not associated with a concomitant increase in general achievement efforts in free-play. To the degree that such achievement efforts reflected general achievement motivation, the specific motivation to master previously-failed intellectual tasks does *not* appear to be an integral part of general achievement motivation *per se* in young children—or at least there was no evidence in the present study that this was so.

Second, while no evidence was found to warrant the assumption that intellectual task-mastery motivation was associated with general achievement motivation, the data *did* suggest that the desire to master previously-failed intellectual situations was linked with a general propensity for assertive and independent problem-solving behaviors. At early grade school age, when the boy's repetition choices reflected a greater desire for intellectual task-mastery than the girl's, the boys had also developed more independent and assertive behaviors for handling other situations. In free-play, the boys were less dependent on the approval of others to define the competence of their efforts. Also, they were less prone to seek help when faced with difficulty. Finally, they continued their efforts longer in the face of adversity, withdrawing from threatening situations less readily and frequently than the girls. Conversely, the girls, who avoided returning to the previously-failed task in the repetition choice experiment, exhibited more passive, dependent and failure-avoidant orientations in their free-play behavior.

The findings of the present study indicate that young children's repetition choices following experimentally-induced success and failure in an intellectual situation reflect sex differentiation by early school age, and are associated with the concomitant development of sex differences in other relevant social behaviors. The major dimensions of these social behaviors seem to be those of assertiveness and independence *vs.* passivity and dependence. Finally, all of the sex differences found in the present investigation are theoretically congruent with those obtained in the previously-mentioned Winterbottom study (3). Winterbottom found that the independence training of middle-class boys was initiated earlier, and was emphasized more, than that of middle-class girls. To the degree that such independence training is effective, the sex differences obtained in the present study would be expected to occur in middle-class children. Or put another way, as the result of such differential training, the sex identity picture of middle-class girls allows more passivity and open dependence, while that of middle-class boys requires assertiveness and independence. In the present study, these differences were found in the children's free-play behavior by early grade school age, and were associated with concomitant sex differences in the children's repetition choices following success and failure in the experimental situation.

D. SUMMARY

The present study was concerned with age, sex, and personality differences associated with young children's repetition choices following success and failure in an intellectual achievement situation. Age differences similar to, though less pronounced than, those found in a previous study by Rosenzweig were obtained. The differences in the findings of the two studies were discussed.

In addition, marked sex differences were obtained in the present investigation; boys preferred returning to, and attempting to master, previously-failed tasks while girls were more apt to prefer repeating previously-successful experiences. This difference was not evident at the nursery school age, but was clearly present by early grade school. Concomitant sex differences with age in relevant social behaviors were explored. By early grade school age, the boys were found to be less dependent on peers and adults for help and approval than the girls, and were less ready to withdraw from threatening situations. Relationships between the experimental and social behavior data were discussed with special reference to previous research on differences in independence training provided middle-class children.

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SHORT ARTICLES AND NOTES

The Journal of Genetic Psychology, 1960, **97**, 169-171.

THE RORSCHACH AND INTELLIGENCE: A NOTE OF CAUTION*

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A healthy note of caution is manifest in the reports of studies concerned with the relationship between intellectual assessment and certain Rorschach variables. Lotsof, *et al.* (3, p. 300), conclude: "Thus it would appear that if the clinician attempted to use individual variables of the Rorschach to predict intellectual performance, it would result in inaccurate prediction." An affirmation of this came to the writers' attention in connection with testing and retesting a young third-grader who was referred for pre-academic assessment with a group of applicants to a private school. This particular eight-yearoldster had been administered the Rorschach Test six months earlier as part of a pilot study by the writers. The group referral was a routine requirement of the school's entrance procedure. Thus, the subject's test and retest were not occasioned by reason of psychological impairment.

At the time of the first protocol the child was 7 years, 6 months of age and in the second grade of a local public school. She achieved a Revised-Binet *IQ* of 130 with basal and terminal ages at Years 8 and 12 respectively. Her teacher reported exceptionally good adjustment, ready creativity in arts and crafts, advanced reading ability, and general emotional maturity befitting a child one or two years older. The major reasons for sending the child to the private school six months later were to encourage her creative talents and to take better advantage of her intellectual ability and interests in a more individually guided atmosphere. The retest Revised-Binet *IQ* was 129 with the basal at Year 8 and the terminal at Year 13.

Table 1 is a summary of the test and retest variables usually surveyed for intellectual functioning (1,2). Considering only these indices, Table 1 does not reflect clear cut representations of the intellectual picture elicited by the more highly structured Revised-Binet procedure. In general, the formal and objective Rorschach elements are superficially alike in the test-retest

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* Received in the Editorial Office on December 15, 1958.

protocols. However detailed ratio differences obfuscate interpretations for intellectuality.

TABLE 1
SUMMARY OF TEST (7.5 YEARS) AND RETEST (8.0 YEARS) PROTOCOLS; INTELLIGENCE ELEMENTS

Variables:	Test	Retest
M	3	1
FM	4	1
F	9	18
FC	2	4
CF	2	3
Total R	20	27
Ratios		
F%	45	67
F+%	100	94
A%	50	50
P—(P%)	6—(30)	9—(32)
O responses	0	0
Content categories	5	10
H+A:Hd+Ad	12:3	15:3
Sum C	3	5
M:Sum C	3:4	1:5
W:M	6:4	4:1
W%	30	*15**
D%	70	74!!**
Dd+S%	*0*	11

* Underemphasis.
** Overemphasis.

Similarities are evident for F+, A, P, and O responses and the H+A:Hd+Ad ratio. Discrepancies exist in Total R, F%, Sum C, number of M and W, and content categories; the M:Sum C and W:M ratios; and Manner of Approach emphases. It is interesting to note that the discrepant test-retest ratios are numerically different but directionally identical. For example, M:Sum C ratios are 3:4 and 1:5 for test and retest respectively but both tend in the extratensive direction, albeit with varying degrees of intensity.

The verbatim reports with the vocabulary used, the ideas and their modes of expression elicited in the test and retest records, do not suggest the otherwise indicated superior level of intellectual functioning of this child. It would seem from this rather limited experience that making inferences with regard to intelligence requires more than the performance on the inkblot test alone. Clinicians should confine their interpretations to a description of the person in action and the methods of coping with life phenomena, rather than yielding to generally unsupportable conclusions based on the Rorschach Test only. Extrapolating beyond the data may be a tantalizing temptation but this cannot lead to professional adequacy. The clinician should ask himself which of the two protocols in this instance could be used to assess intellectual functioning and potential of the child.

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BOOKS

Now that there is a special *APA* journal completely devoted to the publication of book reviews, it is no longer necessary that other journals emphasize such publication. It has always been our conviction that book reviews are a secondary order of publication unless they carry information that is just as important as the book. However, the publication of book titles is a very important service, and we shall continue to render that service.

In any given issue of this journal, we may continue to publish one or more book reviews, but we do not consider such publication a major function of this journal. In line with this policy, we can no longer pay for such manuscripts.

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INVITATION FOR MANUSCRIPTS IN THE FIELD OF AGING

The Journal Press

CARL MURCHISON

It seems reasonable that the *Journal of Genetic Psychology* should be expanded importantly into the field of aging, in order that data of decline and disintegration may be readily comparable with the data of growth and specialization. To this end, this journal offers to publish immediately and without basic cost any acceptable manuscripts from the field of aging. If this plan should result in an increase in publication lag, an additional volume will be added to the present two volumes per year.

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STUDIES ON THE BASIC FACTORS IN ANIMAL FIGHTING: V. INTER-SPECIES COEXISTENCE IN FISH*

c/o The Smithsonian Institution

ZING YANG KUO

A. INTRODUCTION

In this and the following two reports, the aim of our study was to discover the main factors which, when not under proper control, would contribute to the disturbance of peace among the members of animals of the same species, or of mixed species living an a communal life. Three classes of vertebrate animals were used, namely, fish, birds, and mammals. The experiments to be described in this paper are mainly concerned with environmental and developmental factors affecting the behavior of fish.

It will be recalled that in the first four reports of this series of investigation on animal fighting, the experiments dealt with the behavior of the individual animal (Japanese grey quail) in its relation with another individual, while in the present report, observations were made on the behavior of one animal in its relation to a social group which was composed of a number of animals of either the same species, or a number of mixed species.

B. PROBLEMS STATED

The problems on which the experiments reported in the following pages were designed to investigate may be stated as follows:

1. What would be the immediate and later reactions to each other when a certain number of fish of the same species whose past developmental history is unknown were introduced to live together?

2. What would be the immediate and later reactions to each other when a certain number of fish of mixed species, developmental history also unknown, were introduced to live together?

3. What and how would the following developmental factors affect the behavior of an animal when it was brought to live together with other individuals of the same species or mixed species?

(*a*) Living in isolation since hatching or early after hatching.

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(*b*) Living together with other animals of the same species since hatching or soon after hatching.

(*c*) Living together with animal or animals of different species.

(*d*) Being brought up and trained as fighters.

(*e*) Certain anti-social behavior patterns undesirable for a peaceful coexistence in an animal society of the same species or mixed species such as aggressiveness or dominance (namely pecking and chasing another fish).

4. Can such anti-social behavior patterns be eliminated? And by what means?

5. How would two habitual enemies react to each other when they were brought together into a peaceful animal community?

In an attempt to study the above problems the following experiments were carried out. It should be noted in passing that during the spawning season the behavior patterns of several species of fish under investigation change considerably and require a separate report. The data reported in this paper are related only to the behavior of the fish out of the spawning season.

C. Experiments

1. *Experiment I*

The purpose of this experiment was to investigate Problem 1 as stated above with reference to fish. Three species of fish were used: (*a*) 60 Chinese fighting fish; (*b*) 60 Red sword tails; and (*c*) 60 Siamese fighting fish. The sizes of the fishes as measured from tip of head to tail end range from 1¼″ to 3¼″ in (*c*); 2¼″ to 4⅙″ in (*b*); and 1⅞ to 3½″ in (*a*). The fishes of each species were introduced simultaneously into a glass water tank 36″ × 12″ × 24″. The tanks were aerated. The temperature was kept above 65° F. in the cold weather. The fishes were fed with dehydrated milk-bread sop ground into fine granule and thoroughly mixed with fine multiple vitamin granules. The behavior of each fish toward each other was observed immediately after it was released into the tanks. (The sexes of each species were equally divided.) Later the observation was made daily for the first six weeks and then, once a week throughout the year.

It will serve no practical purposes to present the statistical data from the records of this experiment. The results could be very briefly stated thus: (*a*) on the first day there were 12 incidences of actual but very brief (one to 5 seconds only) fighting, 5 of which occurred in the tanks containing Siamese fish, 2 among the red sword tailed fish and 5 among the Chinese fighting fish. From the second day on throughout the year not one single case of actual fighting was observed although manoeuvres of fighting between two fish of the same species quite frequently occurred. Besides the usual dominance-relationships which have been extensively studied by other investigators among fishes and other vertebrates, the life in the three tanks which contained separately the three species of fish in this experiment could be described as calm and peaceful throughout the year. Dominance took the form of one fish chasing another until the runner was some distance from the chaser. In case the victim failed to notice the approaching aggressor, he received a "peck" from him before it started to run. Dominance is always one individual over another in any section of the tank both individuals happened to be. In the records of this experiment we could not find a single instance of dominance or fighting which could be interpreted as a case of territorial defence.

Another important and interesting fact from our observation in this experiment is that aggression or domination is almost always encouraged by the non-resistance of the victim of aggression. If the victim makes a stand instead of running away, or makes a counter attack, the aggressor immediately ceases to chase and withdraws from it. In this experiment with three species of fish we have recorded 364 incidences of aggression or dominance. Of the 364 incidences, there are only 18 instances in which the victim of aggression took a stand, showing fighting gesture instead of running away, or even actually pecked back at the aggressor. We have not observed a single instance in which a defensive stand on the part of the victim of aggression or domination would result in an actual fighting. It must be pointed out here, however, that when two trained fighters meet, as we shall see later in this report, a defensive stand, or a counter attack is a sure stimulation to initiate an actual combat between the two.

2. *Experiment II*

This experiment tries to answer Problem 2 as stated above. Seven species of fish, 20 each (half male, half female) were introduced into the same tank. They were (1) Chinese fighting fish; (2) Siamese fighting fish; (3) Red Sword Tails; (4) Angel Fish; (5) Neo tetra; (6) Golden fish; and (7) Pearl Gourami. The sizes of (1), (2), and (3) were approximately the same as those in Experiment I. The sizes of (4), (5), (6), and (7) were 2½" to 3½", 1⅙" to 1¼" and 2½" to 4½", and (7) 2½" to 3⅔ respectively.

The methods of observation and other experimental procedure were the same as those in Experiment I.

The statistical data relative to the dominance-relationships among the fishes in this experiment will not be presented here as they merely confirmed the reports of other investigations. But the following facts from our observations required special notice.

1. Of the 7 species studied, only one species namely gold fish show no signs whatsoever to dominate over another of the same species or another species. The dominance-submission phenomena never occur in this species of fish. The absence of aggressiveness in the gold fish can perhaps be explained by the peculiar shape of their body structure, the globular shape of the body and the wide spread and long tail which makes swift movements such as forward chasing and quick turning difficult. Aggressive act would be impossible in a fish which cannot move swiftly.

2. Not a single case in which fish of other species attempt to peck or chase gold fish was recorded.

3. Of the 536 incidences of one fish attempting to chase or peck another fish recorded in this experiment, there were only 22 cases of aggression committed by fish of one species upon fish of another species. In other words, aggression is almost always inter-individual within the same species rather than inter-species.

4. Of the above observed aggressive acts nearly 95 per cent showed the following characteristics:

a. Chasing stopped under the following conditions:

(*a*) When the chased stopped running.

(*b*) When the chased ran faster than the chaser.

(*c*) When the distance between the chaser and the chased is more than three times of length of the chaser (by rough estimate only).

(*d*) When another fish of the same or different species was watching the chasing closely or stalking at the chaser.

b. Pecking was committed at the tail of the victims and caused the latter to dash away from the attacker.

c. The attack (pecking) was made in a hurried and swift manner and the attacker quickly turned away from scene after the aggressive act was committed. There was no retaliation from the victim. But on some occasions when a third and stronger fish happened to pass by, he would start to chase the aggressor who immediately turned tail and ran.

d. When two animals come face to face with each other, if both moved forward slowly and steadily, there would be no attack on either part. But if one starts to run, the other would chase.

e. No actual fighting between two individuals of either the same species or different species was observed in this experiment.

3. *Experiment III*

This experiment consists of three parts relative to the following developmental factors as they affect the behavior of fish when they were brought to live together with a group of fish, either of the same species or of different species:

a. Part I. Forty Siamese fighting fish were raised in isolation a few days after hatching. When they were about 2″ long they were divided into two groups and introduced to group life. Group 1 was individually introduced into a tank in which 20 Siamese fighting fish had been living together for some time. The reaction of the old inhabitants and the newcomer to each other were observed for one week. Group 2 was individually introduced into a tank in which 10 gold fish (about 2½″ long), 20 Chinese fighting fish (about 2⅓″ long), and 10 angel fish (about 2½″ long) have been living.

The result of this part of the experiment was so clear-cut that statistical presentation of our observations which lasted for four months becomes unnecessary. The moment each of the fish in either group was put into either tank, the old inhabitants in the tank would rush to chase it, or peck at it and the newcomer's only reaction to such bullism was "running." Soon the dominance-relationship became established between the old inhabitants and the new comers. This phenonemon, however, must not be interpreted as a result of the lack of the tendency on the part of the fish raised in isolation to dominate over other fish, for the old inhabitants seemed to give the newcomers neither chance nor time to display their bullism. They pecked at them or chased after them whenever the appearance of the newcomers in the tank was noticed by them. On the other hand, the fish raised in isolation would soon develop social hierarchy (chase or peck and run relationship) among themselves when they were placed together either in a tank by themselves or in the inter-species tank in which Siamese fighting fish or Chinese fighting fish, angel and gold fish have been living together. Furthermore, the dominance-relationship between the old inhabitants and the newcomers was reversed from time to time as the latter became familiar with the tank and more aggressive.

It is of interest to note that throughout the experiments in this report all the gold fish and over 60 per cent of the angel fish always remain peaceful. Each one took no notice of the presence of another individual be it belonging to its own species or another species. Nor were they ever molested by fish of other species. However, in the case of gold fish the ones with protruded eyes were often treated by fish of other species as objects of food and would be eaten up by them.

b. Part II. This part of the experiment included 40 Chinese fighting fish and 40 Siamese fighters, all brought up in isolation and trained as fighters. (The methods of training fighting fish will be described in connection with another report.) The other aspects and experimental procedure are exactly the same as those described in Part I. Table I summarizes the results based on the records of our observations on 300 encounters in the two tanks (one originally inhabited by 20 Chinese fighting fish, the other originally by a mixed species group including 20 Chinese fighting fish as well as the peaceful gold fish). Of these 300 encounters 100 were between the trained fighters themselves, 100 between the trained fighters, and the Chinese fighting fish (old inhabitants) and 100 between the trained fighters and Siamese (also old inhabitants).

From this table several important points would be observed: (*a*) There are great many more actual fightings between the isolated trained fighters themselves than between the trained fighters and the old inhabitants (Chinese as well as Siamese fighting fish). (*b*) Fightings are mostly initiated by the trained fighters rather than by the old inhabitants (92% VS 8% and 95% VS 5%). (*c*) The trained fighters in the greatest majority of incidences of fighting come out as victors (90% and 93%). (*d*) The duration of fighting between the trained fighters themselves is much longer than that between the trained fighters and the old inhabitants. The point to be emphasized here is the striking difference between the trained fighters and untrained fish in their response to the bullism of the old inhabitants which would always rush to chase or peck a newcomer (especially if the newcomer belongs to the same species), as soon as the strangers are spotted by them. In the case of the strangers which are not brought up as fighters their most common reaction to the bullism of the old inhabitants is "to run." "Running" is, in fact, a most effective stimulation for the bullish old inhabitants to more vigorously chase the strangers. With one or more repetitions of such a chase-and-run situation, the dominance-relationship between the old inhabitant and the stranger will be established and may last for many months although the frequency and the distance of chasing by the old inhabitant would be gradually reduced as time went on. On the other hand, in the case of the trained fighter, his reaction to the bullism of the old inhabitant is to stand firm, showing a posture ready for combat, or to initiate an attack on the

TABLE 1
Fighting in Inter-Species Fish Tanks

Fightings among trained fighters			Fightings between trained fighters and old inhabitants (Siamese fighting fish)					Fightings between trained fighters and old inhabitants (Chinese fighting fish)				
No. of incidences of fighting	No. of fish which fought	Average duration of Combat	No. of attacks initiated by trained fighters	No. of attacks initiated by old inhabitants	Incidences of actual fighting	No. of trained fighters as victors	Average duration of Combat	No. of attacks initiated by trained fighters	No. of attacks initiated by old inhabitants	Incidences of actual fighting	No. of trained fighters as victors	Average duration of Combat
	NO. PC	15.28	NO. PC	NO. PC	NO. PC	NO. PC	1.28	NO. PC	NO. PC	NO. PC	NO. PC	1.36
85	33 82.5	seconds	92 92%	8 8%	20 20%	18 90%	seconds	95 95%	5 5%	15 15%	14 93%	seconds

approaching old inhabitant. In many cases, "to stand firm" or "to initiate an attack" was sufficient to repel the aggressor and establish almost permanently dominance-relationship in favor of the stranger or newcomer. In a few cases, even when a counter attack is made by the old inhabitant, the duration of the resulting combat is so brief and the battle is almost always ended in favor of the training newcomer with the establishment of a lasting dominance-relationship.

c. *Part III*. In this part of the experiment an attempt was made to find out the difference of social behavior in fish between fish raised in isolation and those raised in group life (socialized) (but without special training for fighting). A considerably large number of newly hatched Chinese and Siamese fighting fish were used in the experiments. But due to death, poor health, and incomplete records, only 20 males in each of the following groups will be reported here: Group I, 20 Chinese fighting fish (hereafter designated as C_1) and 20 Siamese fighting fish (hereafter designated as S_1); Group II, 20 Siamese fighting fish (S_2); Group III, 20 Chinese fighting fish (C_2) Group IV, 20 Chinese fighting fish (C_{3a}); Group V, 20 Chinese fighting fish (C_{3b}); Group VI, 20 Chinese fighting fish (C_{3c}).

C_1, S_1, C_2 and S_2 were socialized groups. All the C_3 groups were isolated ones. Socialization and isolation were commenced soon after hatching. C_1 and S_1 were raised in the same tank. C_2 and S_2 lived in two separate tanks, each tank containing exclusively 20 fish of either species. Each fish of the C_3 groups was kept in a glass jar. In the socialized tank fish of both species began to chase or peck each other (dominance or bullism) when they were over ½″ in length. But tests were not started until they were about two inches long. The tests were carried out as follows: (*a*) Into the tank (hereafter designated as Tank I) containing C_1 and S_1 10 gold fish and 10 angel fish (both about 2″ long) were permanently added. (*b*) Fish belonging to C_2, S_2, C_{3c} were introduced into Tank I. The reaction of the fish in the tank was observed for 3 hours. Then, the strange fish was removed from Tank I and returned to its own tank or glass jar as the case might be. This procedure was repeated for three days for each fish. (*c*) All fish in C_{3b} were transferred to Tank I at the same time instead of individually. They remained in Tank I for three days instead of being returned to their own glass jars every day (for three days) each day after a three hours' observation. (*d*) None of the fish in C_{3a} was ever placed in Tank I. Instead, each fish was paired individually with fish in various groups socialized as well as isolated. Each pair was observed for three hours, then separated. This was repeated for three days.

The condensed results are presented in Tables 2 and 3. Table 2 summaries the dominance-relationships between the various groups. The arrow (→) indicates the direction of domination, which in the case of fish means pecking, attempt at pecking, or chasing by the dominant fish while the submissive fish runs away from the aggressor. Table 3 gives the incidences and percentage of fighting between individuals of the various groups. It will be noticed: (*a*) that when fighting fish of two different species were raised together in the same tank soon after hatching the tendency of domination of one individual over another seems to cross the species line (see Table 2 the columns indicated by $C_1 \rightarrow S_1$, $C_1 \rightarrow S_2$, $S_1 \rightarrow C_1$ and $S_1 \rightarrow C_2$). On the other hand, when fish of the two species were raised in separate tanks, there is only a very low percentage of domination which crosses the species line.[1] (*b*) That the incidences of actual combat or fighting between socialized individuals are only slightly more than half of those occurring between the socialized and isolated individuals, and only 1/12 as many as those occurring between isolated individuals. This clearly indicates that the tendency to initiate attack or to make counter attack is very much stronger among the isolated individuals than among the socialized ones. It must be stated here that all isolated animals as well as trained fighters in the previous experiment were later placed to live in Tank I, the inter-species tank, resulting in a more or less permanent establishment of dominance-relationship among themselves as well as among them and the original inhabitants of the tank. And for five months, not a single instance of fighting was recorded. (*c*) And that fighting took place only between individuals of the same species. The species line had never been crossed in fighting as far as the present investigation is concerned.

4. *Experiment IV*

This experiment deals with Problem 4, namely, ways and means to cause the extinction of the habit of domination of animal over another in an animal community. In the case of fish we employed only one method, namely, selecting much stronger and more aggressive fish to suppress or subdue those which had already built up a habit of bullying the weaker ones. We used three species, Siamese fighting fish, Chinese fighting fish, and red sword tails, each species consisting of 40 aggressive fish. Each of these 40 aggressive fish was paired by a much stronger, and much more

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[1] Experiments are under way to determine the factors which make or break the species barrier in fish in connection with domination or fighting. As will be seen in the next two articles in birds and mammals, the species line (or even class line) is often broken not only in fighting and social domination but also in sociable behaviour.

TABLE 2

C1→ S1		S1→ C1		C1→ C1		S1→ S1		C2→ C2		C2→ S2		S2→ S2		S2→ C2	
NO.	PC	NO.	PC	NO.	PC	NO.	PC	NO.	PC	NO.	PC	NO.	PC	NO.	PC
12	60%	9	45%	18	90%	15	75%	14	70%	2	10%	16	80%	1	5%

C1→ C2		C1→ S2		C2→ S1		C2→ C1		S1→ C2		S1→ S2		S2→ S1		S2→ C1	
NO.	PC	NO.	PC	NO.	PC	NO.	PC	NO.	PC	NO.	PC	NO.	PC	NO.	PC
16	80%	10	50%	2	10%	17	85%	10	50%	14	70%	19	95%	1	5%

TABLE 3

Total incidences of Fighting	Fighting between:							
	Socialized and socialized		Socialized and isolated		Isolated and isolated		Two different species (Chinese and Siamese Fish)	
	NO.	PC	NO.	PC	NO.	PC	NO.	PC
126	8	6.35%	22	17.46%	96	79.39%	0	0

aggressive fish of the same species. Each pair was simultaneously introduced into a fish tank in which a large number of fish of several peaceful species such as gold fish, etc., had been living. The reaction of the pair to each other was carefully observed. After observation for three days the stronger fish was withdrawn and replaced by one (same species) which was even smaller and weaker than the one left in the tank. After another two days this weaker one was withdrawn and replaced by the one (former victim) which the former aggressor (still left in the tank) used to chase or peck. An observation of the reaction between the former aggressor and its former victim was made for another three days. The results of this experiment were summarized in Table 4. It appears that in a great majority of

TABLE 4

Species	Aggression subdued by stronger, bigger and more aggressive fish		Aggression reappear when more aggressive animal not in sight		Aggression reappeared former victims in sight	
	NO.	PC	NO.	PC	NO.	PC
Siamese fighting fish	32	80%	30	93.75%	30	93.75%
Chinese fighting fish	28	70%	24	85.71%	26	92.85%
Red sword tail	36	90%	15	41.66%	18	50%

cases (70% to 90%) the aggressive habit in these species of fish could be subdued or suppressed by another bigger and stronger aggressor. However, the suppression is by no means permanent as can be seen from the second and third vertical columns of the table in which the aggressive habit reappears after the stronger aggressor is removed from the tank or after the former victim of aggression is placed in the tank. In our record there are 10 Chinese fighting fish whose aggressive habit had been suppressed by one giant fish of the same species which was almost twice the size of the suppressed aggressors. This suppression went on from 8 to 10 months. Then, the giant fish was removed from the tank. The giant fish lived with the 10 suppressed aggressors by rotation. When the 9 aggressors were not living with the giant fish, they were kept in isolation. Each of the 10 suppressed aggressors was tested separately for reappearance of the aggressive habit by placing a weaker and smaller fish of its species in the inter-species tank. In practically every case it began to bully the smaller fish within one hour.

5. *Experiment V*

In this experiment we were concerned with the fifth problem stated above, namely, what would the habitual enemies who were brought up to fight whenever they were placed face to face in a small tank react to each other when they were put together in a large tank in which a number of fish of several species were living peacefully. We used two groups of Chinese fighting fish for this experiment. Group 1 consists of 32 pairs of fish who had fought on a number of occasions, but the combat was indecisive when we commenced to introduce them (one pair of habitual enemies at a time) into the inter-species tank. There were 30 pairs of fish of habitual enemies in Group 2. In this group each pair of habitual enemies was placed in the inter-species tank after their combat had reached a definite decision. In both groups, observation was made on each pair for two hours. After two hours, the pair was taken out from the inter-species tank and put back to their original isolation jars. This procedure was repeated for four days. The results are shown in Table 5.

It seems noteworthy that, of 32 pairs of fish whose previous combats before being introduced into the inter-species tank had not reached a definite decision, 28 pairs (87.5%) started to fight in the interspecies tank. After one to three fights, the dominance-relationship was established in favor of the victors (26 pairs, or 81.25%).

There is not a single instance in which the dominance-relationship was established in favor of the vanquishers. As always was the case the dominance-relationship in our study of the fish consisted of chasing or pecking the vanquisher or submission by the victor or the dominant, and the running away of the former from the latter. Such a dominance-relationship remains stable and the fighting very rarely, if ever, takes place for many months.

It is of some interest to note also that in this experiment, six pairs of fish, from the beginning of introduction into the inter-species tank, lived peace-

TABLE 5
Combat indecisive before introduction into inter-species tank (Group I)

No. of pairs employed	Fighting in inter-species tank		Dominance relationship established in favor of victors		Dominance relationship in favor of vanquisher		Peaceful living without fight or dominance	
	No. of pairs	PC	No. of pairs	PC	No. of pairs	PC	No. of pairs	PC
32 pairs	28	87.5%	26	81.25%	0	0	6	18.78%

Combat decisive before introduction into inter-species tank (Group II)

No. of pairs employed	Fighting initiated by former victors		Fighting initiated by former vanquisher		No Fighting					
					Dominance by former victors		Dominance by former vanquisher		Peaceful living without fight or dominance	
	No. of pairs	PC	No. of pairs	PC	No. of pairs	PC	No. of pairs	PC	No. of pairs	PC
30 pairs	4	13.33%	0	0	24	80%	2	6.66%	4	13.33%

fully without either actual fighting, or the chase-or peck-and-run-away phenomenon.

With reference to the 30 pairs of previous enemies in Group 2 only four pairs started to fight, all being initiated by the former victors, whereas in Group 1, 28 pairs had fought in the inter-species tank. On the other hand, as to the dominance-relationship and peaceful living without either fighting or domination, the results seem to be very similar in both groups.

D. SUMMARY AND DISCUSSION

A number of experiments in this report were carried out to answer several questions relative to interspecies coexistence in fish. The following sums up the essential points of our findings:

1. There are certain species of fish such as gold fish and most angel fish, etc., which, though living in the same tank are indifferent to each other and in which the so-called dominance-relationship do not exist. Their relationship with fishes of other species, even aggressive ones, can also be described as mutual indifference.

2. The dominance relationship rarely crosses species line. But when two

fighting species are brought up together in the same tank soon after hatching, the species line is broken to some extent.

3. No actual fighting has been observed between two individuals of two different species even though they may be reared together in the same tank.

4. Isolated fish are very much more apt to fight than the socialized ones.

5. However, isolated fish as well as trained fighters can also be socialized in inter-species tanks and follow the general principle of dominance-relationship in fish.

6. A dominating fish could be subdued or suppressed by a stronger one of either the same species or a different species. But such a suppression is not permanent. Soon after the suppresser disappears from the scene the dominating habit of the suppressed one reappears.

7. When one top ranking dominating animal is subdued, another fish steps up to take its place and becomes a new top ranking fish, and this may be followed by a reshuffle of the orders of ranking in the fish society. There is no end to social domination of one fish over another.

8. It must be stressed here that an aggressive act in fish (as well as in birds and mammals) in the greatest majority of cases, is most often committed without resulting in fighting. The suddenness of an attack or chase by the aggressor is almost always sufficient to frighten away its victim. And if this is repeated once or more, the dominance-relationship is eventually established unless the two animals are separated and the victim had time and chance to grow in strength, or to recover from fear of the aggressor (barring nutritional and hormonal treatment of either animal).

In the few cases in which the aggressive act fails to frighten away the victim which, on the contrary, "stands firm" and shows its readiness to fight the aggressor is generally discouraged by such a firm stand and backs away. In some rare cases in which an attack meets with a counter attack the result is a brief fighting. (Fighting as a rule, is quite brief, unless experienced or trained fighters are involved.)

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STUDIES ON THE BASIC FACTORS IN ANIMAL FIGHTING: VI. INTER-SPECIES COEXISTENCE IN BIRDS*

c/o The Smithsonian Institution

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A. PROBLEM

In this report we shall present a number of experiments with a view (*a*) to correct and prevent the development of certain patterns of anti-social behaviour in birds which are undesirable for a peaceful life in an animal community; (*b*) to develop certain patterns of inter-individual attachment between birds of different species; (*c*) to socialize birds brought up in isolation; and (*d*) to eliminate the fear or hostile reaction patterns to the presence of strange birds.

In this series of experiments, the methods which make use of the factors of nutrition and hormones as well as physical punishment (such as electric shock) were not employed, for when we mapped out the program of this investigation we felt strongly that developmental and environmental factors alone were sufficiently potent to modify and condition animal behaviour (birds as well as mammals) towards our goal without resorting to such drastic measures.

For the convenience of presentation of our data we shall divide the experiments in this report into several groups.

B. GROUP I (GREY QUAILS)

In this group of experiments the animals used were Japanese grey quails. Raised in a flock, birds of this species have a gregarious tendency. On quiet moments these birds would congregate in a corner and rest with apparent tranquillity. But one of them would suddenly leap up and peck violently at another which starts to run and a wild chase follows. The corner is then, disturbed (sometimes even the whole flock). Other dominant birds, too, start to peck and chase submissive ones, according to their social ranks. The birds in the middle range of ranking are often pecked as well as peck others. The situation is very similar to that existing in the flocks of domestic chickens

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except that pecking is much more severe and chasing is much swifter in quails than in chickens, as the quails are extremely small in size with a short neck, small head and very small and low comb in comparison with domestic chickens. Due to violent pecking and coition, a whole flock of birds except a few top ranking ones rarely have full feathers covering the head and upper part of the neck; and very often, the skin of the head and neck are torn. Occasionally, peckings elicit counter peckings which often result in a very brief fighting. At other times a few birds would crouch closely on the floor, scratching the floor, gently and slightly pecking each other's neck.

In sex behaviour, unlike the domestic chickens, there are no food-calls to attract the hen, wing fluttering and waltzing by the male; and there is no positive response (crouching) on the part of the female. When the male quail meets the female it starts to leap on the latter which tries to run away. The male grasps her neck or head and performs coition while the female is still running. If the grasping is loosened, the female gets away from him, a chase follows until the female's neck or head is grasped again, the male leaps on her back and coition is accomplished (often in a very hurried manner as the female never stops running throughout the whole event). Quartered in a bird house of many species, quails maintain an almost complete indifferent attitude towards birds of other species except that when birds of smaller size than the quails come too close to them, the latter would peck them and chase them away.

This brief description represents almost the entire repertoire of the quail's social behaviour under non-experimental conditions. The purpose of our experiments to be described presently was to correct or prevent the development of pecking behaviour in the animal with a hope that the so called dominance-relationship in the quails may be abolished or not developed.

1. *Experiment I*

In this experiment we tried to tame the dominant animals by the method of suppression or subduing: 25 most aggressive birds were selected from several flocks. These would challenge, peck, or chase when they met weaker or strange quails in the flock. As suppressors or subduers, we selected five trained fighting quails which would start a fierce battle whenever and wherever they were challenged or attacked by other quails. As they were well trained and experienced fighters, none of the aggressive birds in the ordinary quail flock could be their match. So in every battle the non-trained aggressor received a sound beating, often with loss of head and neck feathers and even tearing and bleeding of skin. The experimenter gently introduced a trained fighter into the flock to attract the attention of one of the top ranking aggressors who would rush to challenge or attack the stranger. Fighting resulted. The untrained aggressor would give up the fight in one to four seconds, but the trained fighter kept on pecking until the loser managed to escape or the experimenter came to separate them. None of the 25 selected aggressors would attempt to challenge the trained fighters again even after an interval of three weeks, five of them received such severe injury in the fight that they had to be removed from the flock to nurse their wounds. Fifteen out of the 25 birds never became dominant again in the flock. The rest resumed their aggressive attitude towards some other birds in the flock after one to six days' quietude after the fight, but every one of them became much less aggressive than before. and occupied a much lower rank in the flock. However, as in the case of fish, after the top rank aggressors were subdued, other birds moved up to take their places as the most dominant birds in the flock.

2. *Experiment II*

In this experiment the method of isolation was employed. Sixty newly hatched quails were divided into three groups; Group 1 lived in isolation for two weeks after hatching; Group 2 for four weeks; Group 3 for three months. After the prescribed periods of isolation, the birds of each group were put to live together so as to socialize them and their social behaviour was recorded until the birds were 10 months old. A summary of the results is presented in Table 1.

Several points are to be observed in this table; (*a*) the longer the birds were raised in isolation, the more difficult it was to socialize them (that is, to make them mingle with other quails and to have normal sex activities). (*b*) In those birds in which socialization was possible after a certain period of isolation, the tendency to develop dominance over one another was still considerable (33.5% to 50%). And (*c*) hand in hand with the increased tendency to live in solitude in those birds with longer period of isolation, there was a stronger tendeny of becoming intolerant of the presence of other quails, which intolerance, frequently resulted in fighting.

It seems safe, then, to conclude that isolation is not a successful method for elimination or reduction of social domination in quails. On the contrary, it tends to develop social intolerance, and hence, the propensity to fighting.

TABLE 1

Length of time of isolation	Two weeks (Group I)		One month (Group II)		Three month's (Group III)	
	No.	P.C.	No.	P.C.	No.	P.C.
(1) Birds socialized	15	75%	9	45%	4	20%
(2) Birds developing dominating behaviour	6	40%	3	33.33%	2	50%
(3) Birds remaining in solitude	5	25%	11	55%	16	80%
(4) Birds with tendency to fight	8	40%	12	60%	14	70%

The grey quail is a very poor social animal after all. Its total social behaviour, as has been stated, consists of merely chasing and pecking one another, and leaping on another's back, grasping its neck and performing coitus, when the bird, male or female, under its feet, does not succeed in freeing itself fast enough. There is no parental care on the part of the male, nor is there any positive sex response on the part of the female. Those patterns of behaviour which may be described as friendliness, mutual attachments, and fondliness, and which are essential elements in a peaceful and lively animal society, are wholly non-existent in the quail. We now turn to those experiments on those species of birds in which such sociable elements of behaviour could be developed.

C. GROUP II (MASKED JAY THRUSH)

The Masked Jay Thrush (pryonastes paricillatus)[1] is a song bird common in South China, Siam, and Indo-China, having dark-blue and white plumage, slightly smaller in size than the European starling. In wild it feeds mostly on insects, but in captivity, it eats almost anything, from meat, fish, sea food, to milk sop and canary seeds. Except during the breeding season when the male helps the female feed the young, it lives a solitary life.

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[1] This species was referred to in the table of the first article of this series as "Chinese Blue Bird," the name we adopted in our laboratory.

Males often fight savagely in the tree. At day break, however, when one male starts to sing, other males in the neighborhood one by one join the chorus. In cage the male is most hostile to any bird of its size or smaller and would viciously attack or fight any stranger, another male jay thrush or even a female jay thrush, or a Chinese song thrush; often it kills and eats small birds such as the strawberry finch, the South China white eye and the Peking robin; but it could be easily frightened by a bird much bigger in size such as pigeons, parrots, etc.

In the following two experiments an attempt was made to bring up the jay thrush in such an environmental setting as to make it become friendly to (*a*) members of its own species, (*b*) birds of very much smaller sizes, and (*c*) birds of very much bigger size.

1. *Experiment I*

We had not been able to breed the masked jay thrush in the laboratory. Forty-eight chick thrushes were bought from peddlers who caught them in the trees. Their age ranged from 5 to 10 days (by estimate) old. They were divided into two groups of 24 each, one group used for *Experiment I,* the other group, for *Experiment II.*

The chick thrushes were subdivided into three sections of eight chicks each. One section was put into a house in which 10 fully grown Peking robins had been living for sometime. The second section was placed together with 10 fully grown South China white eyes. The third section joined 10 strawberry finches in the latter's house.

The Peking robin (Laothrix Lutea Lutea) is about the size of a canary. The male sings quite well. The South China white eyes (Zosterops Sivirler) is about ½ the size of the Peking robin. The size of the strawberry finch (Amandava Amandava) is smaller than that of the white eye. These last two species also sing very pleasantly. Both the Peking robin and white eye eat almost everything that the jay thrush eats. But the finch takes only bird seeds. The robins and white eyes are most gregarious birds. At rest, night and day, they are always crowded together, often one bird sticking its beak under the feather of the neck of another, or under its wing, caressing, grooming one another regardless of sex. In the wild they always fly in groups. When one is left alone, it makes lonely cries which is invariably replied to by other birds of both sexes of the same species in distance. By following the calling of other birds of its species the lonely bird could find its companions wherever they are, often at the risk of running into a trap set up by a bird catcher. Both the Peking robin and white eyes are almost completely free from the syndromes of the dominance-submission-relationships, although occasionally, two birds competing for a favorite roosting place, or for a food dish make some very brief gestures as if they were about to fight. Both sexes never fail to reply to the calling of some lonely bird of their kind at some distance and would rush to join a newcomer from outside. Hostility to strangers is completely absent. Such friendly and non-dominating patterns of behaviour are extended to birds of other species. For example, a Peking robin or a white eye will roost together with a song thrush—no relation to the jay thrush—which will, in cold weather, loose its wings to cover a robin or a white eye on either side. The song thrush and the robin or white eye often exchange grooming. (The song thrush is somewhat larger than the European Starling and often raised as a pet song bird. Many people in China trained song thrushes as fighters too, as quails are.) But the response of a house sparrow or a Java sparrow, a parakeet or a masked jay thrush to such friendly and sociable acts is violent attack on these birds of peace.

In the strawberry finch there is a rather rare and mild degree of dominance relationship. The attack by the dominant on the submissive is neither frequent, nor violent. We used the strawberry finch for these experiments, partly because of its extremely small size and partly because these birds mingle peacefully with the robins and white eyes.

So, our aim in this experiment was to bring up the recently hatched jay thrushes in such a manner that when fully grown, they would become friendly companions of birds of much smaller size, instead of their killers or attackers of strangers.

Each section of the chick thrushes was put in a wooden bird cage, 14″ x 18″ x 16″ (high) which was placed in a small bird house (8′ high x 5′ x 5′) made of wire-net in which the peking robins, white eyes, or strawberry finches, as the case may be, flew about freely. For the first 10 to 14 days the young thrushes were fed by hand. Food for the robins was also placed inside the wooden cage so that the robins would go in and out frequently to feed themselves in the same place where the growing young thrushes rested. When the thrushes were old enough to feed themselves, they ate the same kind of food the robins ate at the same place. The food was so abundant and so widely spread on the floor that there was little chance for competition over food. Before they could fly, the chick thrushes rested at night on the floor of the wooden cage while the robins were trained to rest on a perch above the floor. Every day a stranger bird of various species the sizes of which were always smaller or no larger than that of the robin was introduced into the birdhouse and ate and rested in the same wooden cage. The next day the stranger was removed and another stranger came to take its place. After the young thrushes were about 6 months old, strangers were introduced into bird houses weekly instead of daily. This was repeated for another six months.

The same procedure was carried out with the other two sections of chick jay thrushes with whom the white eyes and strawberry finches were housed.

The results may be briefly summed up as follows:

1. No experimental jay thrush was observed ever to attack or show hostile attitude towards a stranger or its companion of either its own species or other species. Nor was there any symptoms of dominating behaviour.

2. The thrush would stay alone, if let alone, but show no signs of objection when it was sandwiched between two smaller birds at night.

3. When one jay thrush was left alone in the house, there was no sign of loneliness distress or calling for the missing mates; and when its companions were returned to the house, there were no activities which could be interpreted as acts of "reunion."

4. There was no act on the part of the experimental bird which could be regarded as behaviour of caressing or fondling, or even of friendliness towards its own species of either sex, or the smaller species.

5. When the breeding season arrived the male and female experimental animals began to become interested in each other. But before we were certain whether breeding of this species in the laboratory was possible we were compelled to abandon the laboratory due to political upheaval and student riots.

From these results we may conclude that negatively we were successful in preventing the experimental animals from building up such anti-social habits as attacking strangers, bullying or even killing and eating birds of much smaller sizes, but positively, we failed to build up such friendly and sociable habits as found in the Peking robins and South China white eyes. The masked jay thrush is basically a solitary bird under whatever environmental conditions it is brought up.

2. *Experiment II*

In this experiment 24 recently hatched masked jay thrushes were housed together with 20 parrots of various sizes ranging from two parakeets of the size of a magpie to two large white cockatoos. These parrots were well tamed in the laboratory and had become tolerant of the presence of small birds of different species in the bird house which was twice the size of the one used in Experiment I. The two white cockatoos had been trained to tolerate various small birds to perch on their backs. The chick jay thrushes were often fed on the back of the cockatoos before they could fly. After they could fly, they were induced to perch on the cockatoo's back to be fed with worms. Other details of experimental procedure were identical with those of Experiment I, except that the introduction of strangers as visitors included various sizes ranging from strawberry finches to cockatoos. The behaviour patterns of the experimental birds were almost identical with those described in Experiment I. Besides, they were neither afraid of, nor interested in, any big birds, either old companions, or total strangers. But every jay thrush had grown quite used to perch on the backs of the two white cockatoos as if they were nothing more than landing grounds to them.

In brief, both of these two experiments have demonstrated that the young masked jay thrushes could be reared in such an environment as to develop a high degree of tolerance of, not only the presence of strangers but also the intimate bodily contacts with birds of various sizes and various species; and that those positive sociable habits such as acts of fondling, restlessness, and calling for mates when alone, and rushing to join them when in sight or heard, could not be developed in this species.

D. Group III (The Sparrows)

In an aviary of numerous species and various sizes the masked jay thrush, the Java grey sparrow, and the house sparrow are the worst enemies of peace. The parakeets may fight among themselves, may even attack birds of smaller species. But they do so only on certain occasions, and generally they attack only when other birds come too close to them or interfere with them when they are eating. The jay thrush, the Java sparrows, and the house sparrows not only fight among themselves furiously for as long as 18 minutes, but they also play havoc to the birds of smaller species, especially the Peking robins, the white eyes, and various species of finches. There is no space limit for them. The Java sparrows even attempt to chase peaceful birds 3 or 4 times their size. In the last two experiments we have shown that the formation of such anti-social habits in the jay thrush could be prevented by developmental methods. In the following we shall describe the methods and results of our experiments to cure and prevent such anti-social behaviour patterns in the sparrows of both species.

1. *Experiment I*

We have not succeeded in breeding the Java sparrow in the laboratory. We selected 40 fully grown and most aggressive birds and divided them into two groups. Each of the birds in Group I was placed in a cage in which an extremely vicious jay thrush was living. Immediately the thrush started its violent attack on the stranger. When the experimenter was satisfied that the sparrow was thoroughly beaten, it was taken out from the cage (in case of injury, it was put in a cage to nurse the wounds) and put into the aviary of a large number of peaceful birds including several masked jay thrushes which were brought up in the laboratory and free from such anti-social habits.

Group II was divided into four sections. Four birds of each section were put into one compartment of a cage partitioned in the middle by a piece of glass, the fifth bird was placed in the other compartment to be attacked by a jay thrush. The four Java sparrows watched in panic through the glass partition the violent attack of the fifth sparrow by a jay thrush. After the attack all the five experimental birds were released into another aviary of peaceful birds.

Here are the main points of the results of this experiment:

1. For three months in the aviary, none of the 24 Java sparrows which had been severely attacked by the jay thrushes showed any symptoms of bullism over the other birds of different species. But seven of them often attempted to bully members of their own species.

2. One to three months after the peaceful thrushes were removed from the aviary, six of these 24 animals began to bully birds of smaller sizes. But their bullism was quite mild in comparison with their original behaviour before they were attacked by the thrushes.

3. Those 16 birds which had not been attacked by the thrushes but merely watched through the glass partition thrushes attacking other members of their own species, showed fear reaction to the thrushes but their aggressiveness or bullism among themselves or towards birds of other species returned within one week in the aviary although the jay thrushes had not been removed.

2. *Experiment II*

The subjects in this experiment were two groups of 20 each baby house sparrows 5 to 8 days after hatching. One group was divided into five sections, ranging from 3 to 5 birds in each sections. Birds in each section were mixed with an equal number of baby white eyes about one week old.

The experimental procedure was identical with that used in *Experiment I* of Group II including regular introduction of strange birds into the bird house as the baby birds were growing. In the other group, only one baby house sparrow instead of 3 to 5 was raised together with 3 to 5 baby white eyes; other details of the experimental procedure are exactly the same as the first group. The behaviour of the young birds of both species in this experiment was observed until they were 12 months old. The results reveal several interesting features: (*a*) In both groups of house sparrows only one out of 20 developed syndromes of aggressiveness towards its own nest mate; and two out of 20 in Group I, and three out of 20 in Group II attack birds of smaller or similar size other than their own nest mates. (*b*) The same birds which developed symptoms of aggression, when in solitude, showed no symptoms of restlessness, calling for nest mates, rushing to join them, when nest mates returned (such symptoms are typical of the behaviour of the white eye when it is raised together in the nest with other baby white eyes). (*c*) At night these birds still joined other experimental birds and perched very closely on the same perch, like the white eyes, preferring to be sandwiched between two birds, or under the wings of a many times larger bird—such as the song thrush which is extremely tolerant of smaller birds. (*d*) Group I had no noticeable preference in their association with the white eyes and those of their own species. In Group II in which only one chick sparrow was raised together with 3 to 5 chick white eyes, 14 or 70 per cent preferred to be with white eyes, while two or 10 per cent had no choice whether to be with other sparrows or with the white eyes. And (*e*) except those which developed aggressive symptoms and were hostile to strange birds especially of their own or smaller sizes, all the other sparrows in both groups were either friendly (53.33%) or indifferent (46.67%) to strangers of about the same size.

3. *Experiment III*

It is to be noted that in all the experiments already described in this report, the experimental animals were given plenty of food each day, and were fed or ate separately or individually during the experimental period so that the chances for competition over food was practically eliminated. The purpose of the present experiment was to see how keen competition over food during the growing period would affect the development of the syndromes of aggression. Twenty white eyes chicks and 20 baby house sparrows were used. Every experimental detail was the same as Experiment II with one exception: that the growing young birds were fed or ate together in groups of 3 to 5 birds. During feeding the young had to struggle hard in order to catch a piece of food. The results show that 8 out of 20 or 40 per cent of the chick sparrows developed aggressive symptoms which often resulted in a battle, and four or 20 per cent of the chick white eyes become aggressive, two of them involved in mild physical combat. The rest of the experimental subjects of both species, when fully grown up, possessed no anti-social habits, and their behaviour patterns were similar to those in the great majority of the birds in Experiment II.

E. GROUP IV (PEKING ROBINS AND SOUTH CHINA WHITE EYES)

We have noted that the Peking robins and the South China white eyes developed under non-experimental (or the so called "normal") conditions, possess certain behavioural traits which we have regarded as sociable behaviour patterns. These are (*a*) the tendency to live together with other birds of same species, or to be close together with birds of other species; (*b*) inter-individual attachment, thus, when in solitude, calling for mates, and rushing to join them when mates return; (*c*) when alone, would track the sounds of other birds even strangers of the same species in order to join them; and (*d*) friendly to strangers especially of same species and hence the almost complete absence of the syndromes of behaviour which have been called "territorial defence." In the experiments to be related presently an attempt was made to find out the effect of isolation on such behavioural traits in these species.

1. *Experiment I*

Forty fully grown Peking robins were divided into four groups. Each bird of Group I was isolated for one month; Group II for two months; Group III for four months; and Group IV for six months. During the isolation period, the subjects were prevented from seeing or hearing the sounds of other Peking robins. By the end of the isolation period, each bird was released into the aviary in which among birds of many other species, there were a number of Peking robins. The reaction of the released bird in the aviary was observed every day for three days, and then every week for four weeks.

2. *Experiment II*

Forty fully grown South China white eyes were employed in this experiment. The experimental procedure is exactly the same as *Experiment I*.

3. *Experiment III*

Forty 5- to 7-days old chick white eyes were the subjects of the experiment. The procedure is identical with *Experiment II.*

The results of these three experiments are presented in Table 2. The table is self-explanatory. Here is a clear revelation of several salient points: (*a*) Of all the three groups of experimental birds no one developed anti-social habits such as attacking, fighting, monopolizing food, or hostile to other birds. (*b*) In the fully grown robins and white eyes, only two robins lost their sociable habits after 6 months isolation, one white eye lost them after 4 months, and one after 6 months. All the birds which lost their sociable habits during isolation developed solitary habits, and were not re-socialized four weeks after returning to the aviary. (*c*) Two or 20 per cent chick white eyes developed solitary habit after one month of isolation; two after two months; four or 40 per cent after four months; and seven or 70 per cent after six months. In other words, the longer the young birds were confined in isolation, the more of them developed solitary

TABLE 2

Subjects Length of Isolation	1 month No.	 PC	2 months No.	 PC	4 months No.	 PC	6 months No.	 PC
					Fully grown robins			
Effects of isolation								
Sociable habits lost	0	0	0	0	0	0	2	20%
Anti-social habits built	0	0	0	0	0	0	0	0
Solitary habits built	0	0	0	0	0	0	2	20%
Effect of re-socialization								
Sociable habit built or returned	10	100%	10	100%	10	100%	8	80%
					Fully grown white eyes			
Effects of isolation								
Sociable habits lost	0	0	0	0	1	10%	1	10%
Anti-social habits built	0	0	0	0	0	0	0	0
Solitary habits built	0	0	0	0	1	10%	1	10%
Effect of re-socialization								
Sociable habit built or returned	10	100%	10	100%	9	90%	9	90%
					Chick white eyes			
Effects of isolation								
Sociable habits lost	0	0	0	0	0	0	0	0
Anti-social habits built	0	0	0	0	0	0	0	0
Solitary habits built	2	20%	2	20%	4	40%	7	70%
Effect of re-socialization								
Sociable habit built or returned	10	100%	8	80%	6	60%	3	30%

habits. Such solitary habits appeared to be permanent (at least not changeable after four weeks in group life). It appears, then that in the birds of these two species once a habit is established, sociable or solitary, it is not transformable. Furthermore although isolation might bring about solitary habits but had not resulted in building or creating a tendency toward anti-social habits quite in contrast to the effects of isolation on the behaviour of the grey quail and the masked jay thrush, both of which develop fighting tendency or hostile attitude towards strangers when raised in isolation.

F. SUMMARY AND DISCUSSION

In this report several groups of experiments were performed on a number of species of birds with a view to determine certain environmental conditions under which certain anti-social behaviour patterns in birds were more easily to be established, or to be modified or to be prevented, and certain other environmental conditions under which certain sociable behaviour patterns could be developed or inhibited from development or could be extended to other species of birds. The following are the salient points of the results of these experiments:

1. Isolation during the growing period leads to the development of solitary habits.

2. Isolation also prevents the development of sociable habits.

3. Isolation facilitates the development of hostile reaction to strangers which may lead to aggressive or fighting behaviour. However, in the case of South China white eyes, such an aggressive type of behaviour was never present even after a long period of isolation soon after hatching.

4. Severe competition for food often leads to the development of aggressive habit or the propencity to fighting. This was even true of the white eyes which normally possess no such habits or propencity.

5. Frequent visits by strange birds of various species and sizes during the growing period will eliminate hostile or fear reaction to strangers.

6. The development of anti-social habits among those species which under normal conditions possess such habits could be prevented if the young birds were brought up together with young birds of those species which normally develop sociable habits instead.

7. Through control of certain environmental conditions during development certain sociable behaviour patterns which normally are manifested only in the inter-individual relationship of the same species could be extended to individuals of other species. We shall see in our next article that the

development of such behaviour patterns could be so controlled as to manifest themselves between individuals of two distinct classes of animals while wholly absent between individuals of the same species.

8. Established aggressive habits in birds could be suppressed or subdued by stronger and more aggressive birds, but only to reappear, though in a milder form, after the suppressor or subduer is removed, and after a period of rest and regaining strength.

9. In birds, as well as in fish and mammals, when one aggressor is suppressed, the animal next in the rank of aggression moves up to take its place as the top aggressor. In group life (composed of individuals of either a single species or a number of different species) once the dominance-submission relationship is established, domination of one individual over another (whether or not it involves physical attack) becomes a perpetual evil. The method of suppression or subduing is effective only in individual cases, but would not work as far as the group as a whole is concerned.

The dominance-submission relationship, however, is by no means a "*necessary evil*" in animal social life. In birds as well as in mammals (see the next article of this series) by controlling environmental conditions during development the formation of certain anti-social habits can be prevented so that a peaceful and tranquil animal society (of a single species or many different species) can be brought into being. An animal society without social ranks has been demonstrated not only by such peaceful birds as the Peking robins and the South China white eyes, but also by such normally fighting birds as the masked jay thrush and the house sparrows. In short, the suppression method is only a corrective measure and applicable only to individuals. It is a therapeutic means which is neither complete nor permanent in suppressing or subduing habits of fighting or domination. On the other hand, the developmental methods are prophylatic measures which seem to be capable of immunizing both birds and mammals against the formation of such anti-social habits as fighting, domination or bullism, food competition, and prey on small animals; they are applicable not only individually but also collectively. Furthermore, under well-controlled environmental settings the developmental methods may bring out certain behaviour patterns in a species in which under non-experimental conditions such behaviour patterns would appear to be lacking as in the case of the peaceful South China white eyes whose aggressive behaviour patterns and the tendency to develop fighting habits have never been observed. But by means of the developmental methods under the conditions of severe food competition such behaviour patterns had been formed. Indeed, it appears that there is a wide range of possibilities in the application of the developmental methods in molding and shaping the behaviour patterns of the animal. We have barely scratched the surface of such methods. Yet the results seem to justify, and call for, greater efforts and further explorations in this direction.

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STUDIES ON THE BASIC FACTORS IN ANIMAL FIGHTING: VII. INTER-SPECIES COEXISTENCE IN MAMMALS*

c/o The Smithsonian Institution

ZING YANG KUO

A. PROBLEM

The purpose of this study is twofold: (*a*) to prevent the formation of certain anti-social habits in the dog and cat such as prey and hunting and killing of smaller animals, antagonism between dogs and cats, and fighting between and domination over members of the same species. And (*b*) to extend or transfer certain sociable behavior patterns to other species. Our ultimate goal was, of course, to establish a peaceful and tranquil mammalian society not only without fighting, but also with the dominance orders or social ranks eliminated. Throughout this investigation the developmental or ontogenic methods were used.

B. THE EXPERIMENTS

The subjects employed in these experiments were newly born puppies, kittens, albino rats, and rabbits. In addition, two species of very young birds, canaries, and cockatoos were included in this research. The subjects were divided into five main groups, each group was subdivided into nine pens, each pen consisting of one animal of one species and five of another species. Thus, in Group 1 Pen 1, one dog and five cats were reared together—see Table 1. The new born animals were put to live together in pens according to the plans of the study as soon as they were old enough to be hand-fed with cow's milk. The sexes of each group were, whenever possible, equally divided. Of the five groups, the first two were used as experimental subjects, the next two groups as controls, and Group V for the study of the effects of isolation on cats and dogs, other species were not involved in this group. Each pen in which six animals of two species lived together was placed in a wire net enclosure 18′ x 18′ x 10′ (high). The detailed arrangements of the four groups are presented in Table 1. In the table, the letters *D*, *C*, *R*, etc. stand for dogs, cats, rats, etc.

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TABLE 1
SPECIES AND NUMBER OF THE NEW BORN ANIMALS REARED TOGETHER IN THE SAME PEN

	Species Pen No.	Cats (C) and cockatoos (Co) Pen 9	Cats (C) and canaries (Ca) Pen 8	Dogs (D) and canaries (Ca) Pen 7	Dogs (D) and cockatoos (Co) Pen 6	Cats (C) and rabbits (Rb) Pen 5	Cats (C) and rats (R) Pen 4	Dogs (D) and rabbits (Rb) Pen 3	Dogs (D) and rats (R) Pen 2	Dogs (D) and cats (C) Pen 1
GROUPS	I	1C 5Co	1C 5Ca	1D 5Ca	1D 5Co	1C 5Rb	1C 5R	1D 5Rb	1D 5R	1D 5C
	II	1Co 5C	1Ca 5C	1Ca 5D	1Co 5D	1Rb 5C	1R 5C	1Rb 5D	1R 5D	1C 5D
	III	1C 5Co	1C 5Ca	1D 5Ca	1D 5Co	1C 5Rb	1C 5R	1D 5Rb	1D 5R	1D 5C
	IV	5Co 5C	5Ca 5C	1Ca 5D	1Co 5D	1Rb 5C	1R 5C	1Rb 5D	1R 5D	1C 5D
	V	Ten dogs and ten cats reared in isolation								

respectively. The figures preceding the letters indicated the number of animals reared together in a pen; thus, 1D 5C means one new born dog reared together with five new born cats.

All the dogs in this investigation were short haired Chinese chows except in the experiments in connection with canaries and cockatoos when newly born Boston terriers were used. The cats belonged to the Chinese local breed. Whenever possible, effects were made to equally divide the new borns from the same litter between Groups I and 3 on the one hand, and between 2 and 4 on the other.

From our studies on the fighting of birds and our preliminary observations on the social behavior of various mammals we had come to the conclusion that competition over food, and over sex, playing activities, hostility towards strangers, and living in isolation were among the major environmental factors leading to the development of such anti-social behavior patterns as mentioned above. In this study, therefore, special emphasis was placed on the control of these factors during development. In the control groups (III and IV) no attempt was made to interfere with the spontaneous development of eating, and play activities of the subjects; these control animals were not allowed to see any strange animals until they were 10 months old. In Group V (dogs and cats reared in isolation) each subject was tested for its reactions to strange animals after they were 10 months old (dogs, cats, rats, rabbits, guinea pags, canaries and cockatoos as well as several other species of birds and mammals).

1. *Socializing Eating Habits*

The object of this part of the investigation was to prevent competition over food by socializing the eating habits of the animals in Group I and II. Only dogs, cats, and cockatoos were used. The cockatoos were included in this study because they could be brought up to become very fond of bread soaked in milk which they could pick up from the food dish for dogs and cats. The procedure is briefly as follows:

When the dogs, the kittens, and cockatoos were about two months old, they were daily brought to eat by turn in the feeding platform the detailed ground plane of which is shown in Figure 1. All the partition walls and doors were made of plate glass. The walls are moveable so that the two compartments, *A* and *B*, as well as the alley way could be widened or narrowed according to the sizes of the animals. There were several sets of doors which could be changed in accordance with the sizes of the two compartments and the alley way. Each door was fixed with a spring hinge and could be opened by pulling the string attached to it. When the string was released, the door closed immediately. Generally, Compartment *A* is so set as to have sufficient room for six animals to move and turn about. The alley way was set to allow only one animal to walk through at a

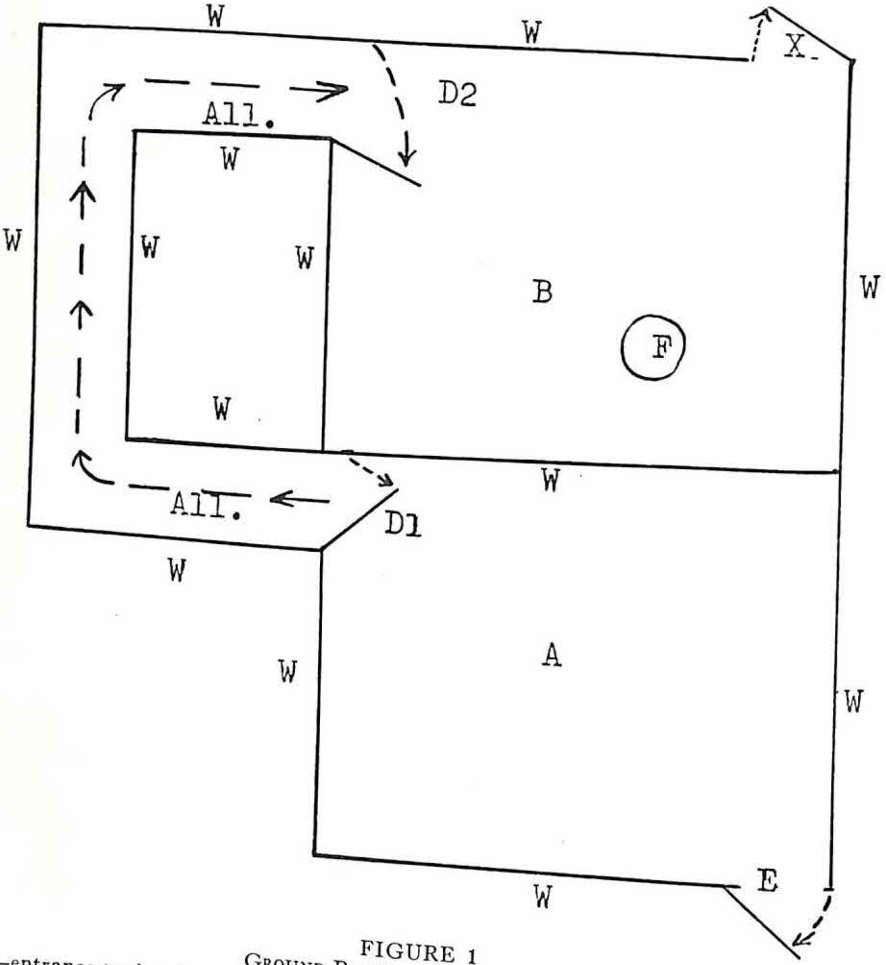

FIGURE 1

Ground Plan of Feeding Platform

E—entrance to the observation compartment.
A—observation compartment.
B—eating compartment.
F—food dish.
D1—glass door leading from A to alley way.
A11—alley way leading from D1 to D2.
D2—glass door from alley way to eating compartment.
X—exit from eating compartment.
W—glass walls.

time so that if a second animal attempted to overtake the first one, it could do so only by squeezing or crawling under the first animal in front. When all the six animals (or five dogs or five cats only in those pens where rabbits or canaries were their coinhabitants) were brought into Compartment *A* through Entrance *E*, one of them was admitted through D1 the alley way and D2 into Compartment *B* to eat in the food dish (F) and the other five animals were allowed to watch the first admitted animal in eating. If any of the watchers became impatient and began to bark or meow, or tried to jump at the partition wall between *A*, *B*, a black curtain was lowered to cover the wall until all the impatient movements and noises in the waiting compartment were quieted down. The animal in eating was allowed to finish his meal in 10 minutes. After 10 minutes the bell rang, and the animal must leave Compartment *B* by the exit (X). Otherwise, he was gently pushed out through X. This done, another animal in waiting was allowed in the same manner to take his meal while the rest of the animals had to wait for their turn. After all the animals in the pen had learned to wait quietly in Compartment *A* for their turns to be admitted to eat in Compartment *B*, the next step in the training was to open Door D1 and let the waiting animals in Compartment *A* file one by one into the alley way while one was already eating in Compartment *B*. At first, the experimenter had to push them one by one into the alley way when the door D1 was opened. But later on all learned to do this without help as soon as D1 was opened. While lining up in the alley way, if one of the animals attempted to overtake another either by squeezing through or by crawling under, the overtaker was immediately brought back to the end of the waiting line.

After all the subjects had learned to line up in the alley way instead of Compartment *A*, each waiting for its turn to be admitted to Compartment *B*, door D2 was kept open. But if the animal in front of the waiting line rushed into Compartment *B* before the animal in eating had finished his meal and left the place, the door was immediately closed and the violator was taken up and replaced at the end of the waiting line. Through a number of trials, all the animals in the pen learned not to enter D2, though it was open, until Compartment *B* was clear of any animal.

One month after every animal in the pen had mastered "the dining car etiquette" (a nickname we used in the laboratory because the process resembled waiting in the dining car in a crowded American train) they were tested for their reactions to a food situation (not in the feeding platform) in which the other animals had either to wait beside the one in eating, or to push him away in order to occupy the food dish which did not allow more than one animal to eat at the same time. Each subject was given three tests.

Since it is not our purpose in this report to analyse the learning process and due to space limitation, the records of the animals of these three species in learning the "dining car etiquette" will not be presented here. Suffice it to state that all the cockatoos, cats, and dogs in Groups I and II had eventually become "socialized" in their eating habit, and that the dogs were the quickest learners, the cats next, the cockatoos the slowest (three to 10 trials for the dogs, eight to 25 trials for the cats, 21 to 29 trials for the cockatoos).

In the three tests in a situation outside the feeding platform all the animals showed that the eating habits, that is, to wait, not to push, if the food dish is occupied, and not to compete with another while trying to reach the food dish which was just unoccupied were preserved even in a new environmental setting, although 56 per cent of the dogs, 42 per cent of the cats, and 33 per cent of the cockatoos often came so close to the food dish and made attempt to sniff at it, but neither the animal in eating objected to it, nor did the sniffer show any sign to join him in eating.

In the control groups (III and IV), no attempt was made to prevent fighting or domination in eating. The feeding plate was large enough for all the six animals in the pen to eat together. The phenomenon of food competition ending in domination without fighting or as a result of one or at most two fightings was observed in the two groups: (66 per cent for dogs, 68 per cent for cats, 48 per cent for rats, and 72 per cent for cockatoos). A dominant dog occupying the food plate or having a piece of food in the mouth would growl to warn off the other animals. A dominant cat would snarl or hiss. A dominant rat would bite another rat. The dominant cockatoo would peck or chase other birds away. The non-dominant ones (dogs, cats, as well as cockatoos) learned to quietly steal a piece of food and run to eat in a corner. A non-dominant cockatoo would steal with its beak one piece of food and put it to one of its feet to hold it, and with the free beak, steal another piece before it went away to eat the stolen food. All these happened when the dogs were about three to four weeks old, cats about four to eight weeks old, rats and cockatoos about two to three months old. All such behavioral phenomena were observed only during feeding time. At other times all the animals living in the same pen were friendly to each other, playing together, and even fondled or are attached to one another.

It would seem that there is a striking contrast in the behavioral patterns relative to the eating habit between the experimenal and control groups.

2. *Play*

In the experimental groups, play of the animals was closely watched every day. The experimenter, with a water spray in hand (the kind commonly used in ironing clothes) would quickly spray water on the face of the animals as soon as fighting started during play. In the chow, puppies of three to four weeks would start to fight during play, or to bite at the handler, but with one to three sprays of water, fighting or biting would not occur again. We also employed water spray on a puppy carrying something in his mouth, who would growl or bite when another animal or the handler tried to snatch it from the mouth. However, in the case of play between cats, between cats and dogs, between dogs and cockatoos, and between cockatoos and cats, no fighting was ever observed. In the case of rabbits and canaries there are no acts which can be interpreted as play activities, except the preliminary and final sex acts.

In the two control groups, fighting between dogs during play was not stopped by the experimenter. But such fightings lasted often only for a few seconds rarely resulting in bodily injury, but might end with the establishment of the dominance relationship in favor of the stronger puppy.

In play activities there is one significant fact which must be pointed out here. There was no species barrier in play. The same kind of play patterns of a dog was manifested in the play either between a dog and a cat or between a dog and a cockatoo. Five of the puppies in all the first four groups even attempted at sham coitus movements on the cats or cockatoos or rabbits. The kittens displayed cat-like play patterns with cockatoos or with dogs. The cockatoos in playing with cats or dogs would nod its head, ruffle its crest, flutter its wings, touching the floor with its beak, attempting billing movements with a dog or a cat, or gently touch the face or neck of the dog or cat with its beak, making tender sounds in the meantime.

In inter-species social life while there is no species barrier in play as well as in attachment or fondling activities, nevertheless, there is still species preference. It will be noted that in the first four groups of animals in this investigation there are six animals of two different species living in one pen. Thus, in Pen 1 in Group I there were one puppy and five kittens living together; in Pen 9 Group I one cat to five cockatoos; in Pen 6 Group II five dogs to one cockatoo, etc. (see Table 1). Now, in the pen with one cockatoo and five dogs, all the attachment, fondling activities, and play of the cockatoo were built around the five puppies. When all the puppies were taken out from the pen, the cockatoo became restless, making loud noises until one of the five puppies was returned to the pen. Even when a strange well-tamed cockatoo was put into this pen, instead of returning a puppy mate, the restless cockatoo adopted an indifferent attitude towards the stranger (or even hostile if the restless cockatoo belonged to Pen 6 Group IV instead of Pen 6 Group II). On the other hand, the attitude of the five puppies in the same pen towards this single avian pen mate can be described as "friendly, occasional playmate, but not indispensable." They did not play with the bird as much as they would among themselves. If four puppies were taken from pen leaving one of the five with the cockatoo, the lone little dog would become as restless and in great distress as if the avian pen mate were not there. The reversal of the same phenomena was observed in the case in which there were five cockatoos to one puppy in the same pen. In this case, the pup became attached almost solely to the cockatoos, acted as if they were his sole companions and play mates while indifferent to other animals including dogs. On the other hand, the cockatoos reacted to this lone dog with a tolerant and indifferent attitude. When two or four cockatoos were paired, their love making activities were confined to their sex mate, becoming indifferent not only to the lone dog, but also to the other cockatoos. And this applies to the relationship between kittens and cockatoos and between kittens and puppies throughout this investigation. In other words, when one young animal grows up together with mates of its species as well as a different species, it is more attached to the mates of its own species than to the mates of another species whereas when one lone young animal of one species is reared together with one or more young of a different species, after the critical time (two to three months), its attachment is in most cases entirely fixed with the mates not belonging to its own species so that when it meets a stranger of its own species its attitude is either indifferent or hostile depending on its past experience with strange animals.

3. *Sex and Fighting*

From the two previous sections we have noted that by socializing eating habit and by experimental intervention of fighting resulting from play activities, our experimental animals of Groups I and II had become practically "domination free" and "fighting free" and that although fighting and domination in eating and in play were observed in the two control groups, they were quite mild and were rarely observed except during feeding time and during play. There was no antagonism between cats and dogs or between cats and rats or any other species used in this investigation. This is true not only of the experimental animals, but also of the control groups. But, now, when the animals in our investigation reached sex maturity, we were confronted with a much more complicated problem. In the first place, we had not succeeded in devising a satisfactory method of procedure, as we had with regard to eating behavior, to socialize sex behavior of the subjects. Secondly, from our past experience previous to this study, we had already known that in a sexually inexperienced but momentarily sexually aroused male chow, there was nothing we could do to stop him from his fierce struggle to reach the female in heat except by a very strong electric shock or an injection of a very heavy dose of estrogen to counteract the presumably momentary hormonal unbalance neither of which would serve our purpose in this type of investigation. Furthermore, fighting over sex between two male cats are frequently violent, and very much more so between two male chows. Such dog fights often ended in a serious injury to both or even death. In order not to upset the peaceful animal societies without or with very little social domination or fighting which we had built for more than 10 months, we decided to suspend our investigation on this aspect of behavior in dogs and cats. Whenever the first signs of the estrous cycle in a female dog or cat were noticed, the animal was immediately removed from the pen and kept in isolation until the receptive period was over (except in Groups I and III in which there was only one dog or one cat in a pen, and Groups V in which every one of the 10 dogs and 10 cats lived in isolation). (In other species in this study, fighting as a result of competition over sex had not been observed.)

C. PREY ON SMALL ANIMALS, HUNTING, REACTION TO STRANGERS, AND THE EFFECTS OF ISOLATION

Kittens and puppies in Group V naturally were not allowed to see any strange animal of whatever species during the period of isolation. From the tenth month on, each was tested bi-weekly for its reaction to strangers including dogs, cats, rats, rabbits, guinea pigs, a number of variety of parrots, canaries, and sparrows. Similarly, the control animals (Groups III, IV) had not seen any strange animal until they were 10 months old, and, thenceforth, each was given a bi-weekly test with the animals of those species used to test Group V. On the other hand, those animals in Groups I and II, from the start of their collective life in the pens were allowed to spend 10 minutes every day with one strange animal of the various species used to test animals in Groups III, IV, and V. These testing animals had been trained to be very tame, having no fear or hostility to strange animals of any species, birds, or mammals but in most cases were very friendly to the animals in the pen they were introduced to visit. The reactions of the kittens and dogs of the five groups to the strange visitors are summed up in Table 2 (the reaction of other species were not presented

TABLE 2

Species of visitors Types of reaction to visitors Group and animals	No.	Indifferent No.	Friendly No.	Hostile No.	Attack No.	Indifferent No.	Friendly No.	Hostile No.	Attack No.
		Cats				*Dogs*			
Group I									
Dogs	5	2	3	0	0	0	5	0	0
Cats	4	1	3	0	0	0	0	0	0
Group II									
Dogs	25	4	21	0	0	5	20	0	0
Cats	21	8	13	0	0	19	2	0	0
Group III									
Dogs	5	1	0	2	2	0	0	3	2
Cats	4	1	0	3	0	3	0	1	0
Group IV									
Dogs	25	2	4	12	7	2	2	8	13
Cats	21	2	2	16	1	4	0	19	2
Group V									
Dogs	10	0	0	6	4	0	1	4	5
Cats	10	1	1	6	2	2	0	6	2
		Rabbits				*Rats*			
Group I									
Dogs	5	4	1	0	0	3	2	0	0
Cats	4	4	0	0	0	4	0	0	0
Group II									
Dogs	25	5	0	0	0	10	15	0	0
Cats	21	20	1	0	0	18	3	0	0
Group III									
Dogs	5	2	0	0	3	2	0	0	3
Cats	4	3	0	0	1	2	0	2	0
Group IV									
Dogs	25	13	3	0	10	13	3	0	2
Cats	21	4	0	18	3	3	2	8	12
Group V									
Dogs	10	1	1	0	8	1	1	0	8
Cats	10	2	0	8	0	2	0	0	8

TABLE 2 (*continued*)

Species of visitors / Types of reaction to visitors / Group and animals	No.	Indifferent No.	Friendly No.	Hostile No.	Attack No.	Indifferent No.	Friendly No.	Hostile No.	Attack No.
		Guinea Pigs				*Canaries*			
Group I									
Dogs	5	2	3	0	0	4	1	0	0
Cats	4	4	0	0	0	4	0	0	0
Group II									
Dogs	25	14	11	0	0	13	12	0	0
Cats	21	21	0	0	0	19	2	0	0
Group III									
Dogs	5	1	0	0	4	4	1	0	0
Cats	4	3	0	1	0	4	0	0	0
Group IV									
Dogs	25	9	0	0	16	14	11	0	0
Cats	21	8	0	8	9	16	3	0	6
Group V									
Dogs	10	2	2	0	6	4	1	0	5
Cats	10	4	0	0	6	5	0	0	5
		Sparrows				*Parrots*			
Group I									
Dogs	5	5	0	0	0	1	4	0	0
Cats	4	4	0	0	0	4	0	0	0
Group II									
Dogs	25	13	12	0	0	8	17	0	0
Cats	21	19	2	0	0	20	1	0	0
Group III									
Dogs	5	5	0	0	0	4	1	0	0
Cats	4	3	0	0	1	4	0	0	0
Group IV									
Dogs	25	9	0	0	16	14	2	4	5
Cats	21	8	0	0	17	8	0	0	17
Group V									
Dogs	10	3	0	0	7	2	3	0	5
Cats	10	3	0	0	7	4	0	6	0

here as our primary interest in this investigation was kittens and puppies. The reason why other species such as rats, rabbits, canaries, and cockatoos were also used was because of the problem of prey on small animals, and hunting in dogs and cats.)

A glance at the table will reveal a number of important points: (*a*) Those cats and dogs which received a strange visitor every day from the very start of the collective life in the pen showed neither hostile nor attacking reaction to the strange animals of any species during the testing period. Gone were their preying and hunting tendencies. Their reaction to strange animals was either indifferent or friendly. Gone, too, was the antagonism or hostile attitude between dog and cats. (*b*) But it is not the case with the cats and dogs in Groups III and IV with which no strange animals were allowed to pay visits. Upon tests, their reaction was by and large hostile or attacking. There were, however, a small number of cases in these two groups in which an indifferent or even friendly attitude was displayed by some of the dogs and cats. Our records show that these dogs or cats were the subjects which were brought up in the same pen with the animals which belong to the same species as the testing animals used as strange visitors to which the dogs and cats in question had displayed an indifferent or friendly attitude instead of a hostile or attacking reaction. (*c*) When we come to the dogs and cats brought up in isolation in the first 10 months, their reactions to strangers are predominantly hostile or attacking although there are a few cases in which the dogs or cats showed an attitude of indifference or a mild degree of friendliness. Our records show 10 cases in which small birds and rats were killed and eaten by the isolated cats, while the dogs chased and killed rats, guinea pigs as well as rabbits and birds. (*d*) The antagonism between cats and dogs, between two dogs and between two cats is very strong as an inspection of the reaction of the animals in Group V to visiting cats and dogs (Table 2) will show.

1. *Suppression of Aggression*

From Table 2 it will be seen that there are 22 dogs in Groups III, IV, and V which would rush to attack strange dogs whenever they were introduced into their enclosure. We purposely selected as visitors to these enclosures, dogs of extreme timidity who will invariably run to escape whenever the resident or residents of the enclosure rushed out and, when an escape was blocked, they would lie down on their backs and let the attackers attack without resistance.

Now, as a last step in this investigation, we made use of 20 (all chows) of these 22 aggressive dogs (the other two, Boston terriers) as experimental subjects on suppression of aggression. The suppressor was a medium sized, short-haired chow with a broad muzzle and with a bodily make-up excellent for a fighter. When we employed this chow as the suppressor for the 20 chow aggressors, it was about three years old. For all the three years of its life this dog never initiated a fight, but when attacked, never failed to make a counter-attack, and never lost a single combat. In any environmental setting, familiar or unfamiliar, whenever he met one or more strange dogs or whenever one or more dogs rush to challenge him, his first and invariable reaction was to stand straight with his tail tightly bent forward to his back, making neither motion nor noise. Such a reaction pattern was in a majority of cases sufficient to send the challengers away without a fight. However, if he was attacked he always fought so well that unless he was ordered to stop by his trainer, the fight was finished almost always with a very serious injury, or death to his opponent. We made this three-year-old chow pay visits to those 20 chows by turn. In case of some mild injury or fatigue, the suppressor was rested until full recovery. Results: 13 of them (65%) were sent away peacefully by his firm and steady stand, the other seven got him into battles which were ended with three cases of severe injury, two cases of light injury, and two cases of death. After the wounds were healed, all these dogs were given four more tests with the suppressor as the visitor and with other new visiting dogs. Results: of the 13 which did not have any fight with the suppressor, six tried to keep in some distance from him, the other got near him but soon left him alone. All the 13 continue to challenge or threaten to attack other visiting dogs. All the injured dogs had the typical reactions of an underdog in the presence of the suppressor. All those which continued to have hostile or attacking reactions to the other dog visitors did so with a milder degree than before.

It must be noted in passing that in Groups III and IV when a top dominant dog or cat was removed from the pen the next dominant animal moved up to take its place as the top ranking animal. The hierarchy or rank order, remained constant until one of the dominant animals was removed.

D. Summary and Conclusion

In a number of experiments it has been demonstrated: (*a*) That in such anti-social behavioral patterns in dogs and cats as have been popularly known as prey on small animals, hunting, mutual antagonism between cats and dogs, aggressive or hostile reactions between two dogs, and hostility to or attacking strangers could be prevented from appearance if appropriate environmental situations were in force during development. (*b*) That sociable behavior patterns in mammals such as attachment to one another, fondling acts and courting could be brought to cross the species barrier and even extended from mammals to birds and vice-versa. This was accomplished also by the developmental or ontogenic methods. (*c*) That by adequate control of environmental conditions during development, eating habits in dogs and cats and even cockatoos could be socialized to resemble human etiquette. (*d*) That during development by elimination of competitions over food, by prevention of fighting during play, and by avoidance of competition over sex, a mammalian society could be immunized against not only fighting but also what has been supposed to be a normal phenomenon in vertebrate animals, namely, the so-called dominance-submission relationship. (*e*) That in mammals as well as in fish and birds, isolation during development has been found to be a major factor in developing hostile reaction to other animals, which reaction is a step leading to fighting. (*f*) That in dogs (cats, also, the data concerning this are not presented in this paper) "standing firm" instead of running or submission has a 65 per cent chance to stop or avoid an aggressive attack. This confirms our findings in fish and birds. (*g*) And that in dogs, too, we confirm the conclusions based on the results of our investigation on fish and birds that an aggressor could be suppressed or subdued by a stronger or more powerful aggressor. But the suppression is never complete nor permanent, and rather costly as such a suppression may lead to severe injuries or even death. Here again, in mammals as in other classes of vertebrates, when the most aggressive animal is removed from the group, another moves up to take its place and established itself as the top aggressor. It appears, then, that suppression of an aggressor or removal of a dominant animal from the group will not end social domination or fighting in an animal society.

Our observation on the behavior of animals towards strangers raised some doubt about the validity of the concept of defense of territory in animals. We are rather inclined to think that the so-called "territorial defence" is, after all, merely a fancy name for the reaction patterns to strangers flavored with anthropomorphism and the 19th century Darwinism. Further and more systemic experimental explorations are necessary to decide this issue.

The results of our investigations on animal fighting have some bearing on the concept of species-specific behavior. We shall take up this question in another paper. (See Kuo—Neo-Behaviorism: A new approach to comparative psychology).

As has been repeatedly pointed out in the previous reports of this series, fixation of behavioral patterns (habituation) during development, plays an important role as a determinant of behavior. Its significance can not be overemphasized. It is an essential controlling factor not only in social domination and fighting but also in the development of behavior in general. We shall elaborate this point in the paper just referred to.

In conclusion, let us restate that although social domination and fighting are very common phenomena in animal societies, and although our studies have demonstrated that once such behavior patterns are formed and once the social hierarchy is established it is extremely difficult, if not impossible, to stamp them out, there is no reason to accept the fatalistic view that such behavioral patterns are "necessary evils" in social life. Our hope for a peaceful and tranquil society without fighting and social domination lies in the prevention of the development of such behavior patterns. Our findings have demonstrated that by appropriate control of environmental conditions during development we can immunize against certain types of anti-social behavior patterns in animals. We seem to be able to accomplish such an immunization without resorting to such drastic measures as depriving the animals of the essential nutritional factors such as thiamin or castration of the gonads. Our experimental attack on the various problems of the elimination of social domination and fighting is just beginning and further and more extensive investigations are required in order to work out a detailed and systematic program for the prophylaxis of aggression in animal society. However, the developmental or ontogenic approach seems to have encouraged us to hope that the day may not be so far off when it will be just as feasible to immunize against social domination and fighting as immunization against smallpox or poliomyelitis.

c/o Dr. Leonard Carmichael
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THE ROLE OF PREFERENCE AND REWARD IN THE SELECTION OF DISCRIMINANDA BY NAIVE AND SOPHISTICATED RHESUS MONKEYS*

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A. PROBLEM

An object-quality discrimination problem requires *S* to choose between two objects, one of which is arbitrarily correct and rewarded, the other incorrect and not rewarded. The fact that *S* is able to make a choice is evidence that it prefers, at least for the moment, one object or position to the remaining object or position. The present experiment is designed to determine the effect of rewarding or not rewarding *S*s' preferences for objects and positions on their selection of particular stimuli from an array of stimuli.

Davis (2) described a technique for reducing the relative number of cues available to *S* on selected trials of discrimination problems. He presented 10-trial problems to monkey *S*s and varied the number of objects present on alternative trials—two objects on odd numbered trials and five objects on even numbered trials. The results of this experiment indicated an interaction between *S*'s preference for an object and *E*'s providing a reward of the object. Also, *S*s with a history of irradiation differed from *S*s that had not been irradiated in response to reward and nonreward of preferences. The present experiment is a direct test of the hypothesis that a reward of a preferred object has a different effect on *S*'s performance than nonreward.

Several specific controls were included in the design of the present experiment. Naive as well as sophisticated *S*s were employed. There were two kinds of trials, noncritical and critical. Two objects, one designated *A* and rewarded, the other *B* and not rewarded, were presented to *S*s on noncritical trials. The number of trials in a problem varied, but the position of the reward was constant for all noncritical trials. The last trial of a problem was designated critical. One of the objects present on the noncritical trials and three unfamiliar objects were presented to *S*, and the positions of the four objects were randomized.

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B. METHOD

1. *Subjects*

Fifteen rhesus monkeys served as *S*s. Six comprised a group each of which had received whole-body irradiation in three doses of 400, 400, and 300 r. administered in successive years. A second group of six *S*s had served as a nonirradiated control group. Each *S* in these groups had received similar training during the six years preceding this experiment and had served as *S*s in the previous experiment which resembled the present study (2). A third group of three *S*s was the progeny of *S*s in the second group and had not received training on discrimination.

2. *Apparatus*

The experiment was conducted in a Wisconsin General Test Apparatus (WGTA). A tray containing four foodwells 3.0 in. apart side-to-side was employed throughout the experiment.

3. *Procedure*

Each *S* received six problems a day for 48 days. A problem consisted of either one, three, or five noncritical trials followed by one critical trial. Two objects, one of which was designated *A* and rewarded, and the other designated *B* and not rewarded, were presented to *S*s on noncritical trials. The positions of the *A* and *B* objects were randomly assigned to two of the four foodwells on the first noncritical trial and remained in that position on all subsequent noncritical trials of that problem.

Four objects were used on all critical trials. The objects were assigned to the four foodwells in the following manner. When the noncritical trials were completed, *E* randomly selected either the *A* or *B* object as one of the four objects to be presented to *S* on a single critical trial. The remaining three objects were unfamiliar to *S*. The positions that these objects occupied, as well as the positions of either the *A* or *B* object were determined from a permuted Latin square. The critical trials were insoluble because they were arbitrarily rewarded with a schedule of 50 per cent reinforcement to all positions. A schedule of 100 per cent reinforcement was rejected because *E* felt that *S*s would develop position habits. Zero per cent reinforcement was rejected because *S*s' responses on critical trials would extinguish.

There were six possible categories of response following the conditions of eliminating the *A* object and six following the elimination of *B*. The responses possible to *S* when the *A* objects was retained on a critical trial were: (*a*)

Object A and Position of A. This occurred if *S* selected the *A* object which occupied on the critical trial the same position that it had on the foregoing noncritical trial. (*b*) *Object A and Position of B*. This category of response was possible if the *A* object occupied on the critical trial the same position that the *B* object had occupied on the noncritical trial. (*c*) *Object A* was recorded if *S* selected the *A* object when it occupied on the critical trial neither the position of the *A* object nor the position of the *B* object of the noncritical trial. (*d*) *Position of A*. Occurrence of this category indicated that *S* selected one of the three neutral objects which occupied the position that the *A* object had occupied on the noncritical trial. (*e*) *Position of B*. This occurred when one of the three neutral objects occupied the position that the *B* object had occupied on the noncritical trial. (*f*) *Neutral*. This category was indicated when a *S* chose one of the three neutral objects introduced on a critical trial when it occupied neither the position of the *A* object nor the position of the *B* object of the noncritical trial.

The possible responses that *S*s could make on a critical trial when the *B* object was retained were: (*a*) *Object B and Position of B*, (*b*) *Object B and Position of A*, (*c*) *Object B*, (*d*) *Position of A*, (*e*) *Position of B*, and (*f*) *Neutral*.

At the end of the first 24 days of training, the number of problems in which the *A* object was eliminated equalled the number of problems in which the *B* object was eliminated. During the last 24 days of training, the same stimuli were employed as during the first 24 days, but the elimination of the *A* or *B* object was reversed for a particular problem.

C. RESULTS

The results relate the performance of *S*s on critical trials to the objects *E*s designate correct and to *S*s' object preferences. Figure 1 summarizes data obtained from *S*s in the three groups when the correct object was eliminated on critical trials.

Naive *S*s respond to the category of *Position of A* more frequently than to the other available categories. The figure also illustrates that *S*s in Groups 1 and 2 respond less to the previously correct position than to either of the categories *Object B* or *Object and Position of B*. The older *S*s differ from *S*s in Group 3 in this respect. Lastly the figure shows that naive *Ss* responded to the confounded category, *Position of A Object B*, less than to *Position of A* alone. Analysis of variance indicated that the interaction between *Categories and Treatment Groups* was significant beyond the 1.0

per cent confidence level using the *Categories by S*s *within Groups* interaction as the error term.

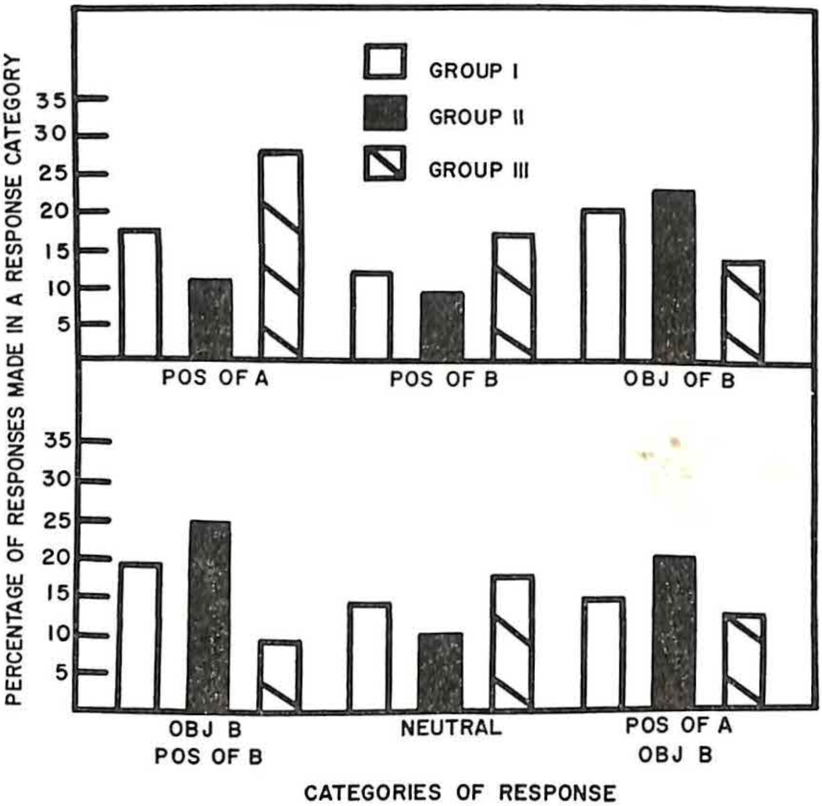

FIGURE 1

Performance of monkeys on insoluble critical trials (CTs) in which the *correct* object was eliminated. Group 1 = Old *S*s with prior irradiation. Group 2 = Old *S*s without prior irradiation. Group 3 = Young naive *S*s.

Figure 2 also presents data which were obtained after the correct object was eliminated. The unfilled bars represent *S*s performance following *S*s' selection of the correct object on all noncritical trials and the filled bars *S*s performance after *S*s' selection of the nonrewarded object on one of the noncritical trials.

The figure shows that the coincidence of reward and preference has little or no effect when the correct object is eliminated.

Figure 3 compares the performance of *S*s in each of the groups when the incorrect object of the noncritical trials was eliminated on the critical trials.

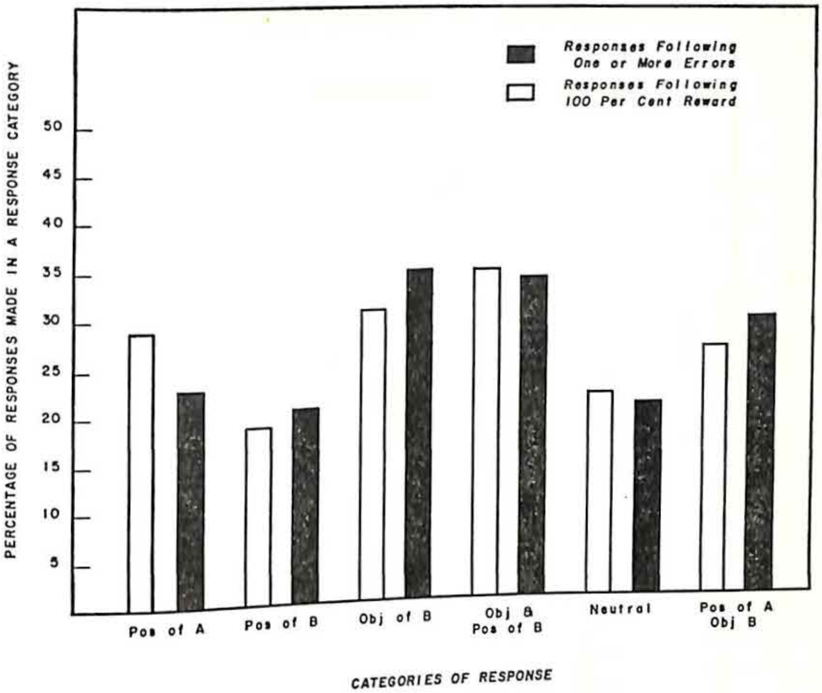

FIGURE 2

Performance of monkeys on insoluble critical trials in which the *correct* object was eliminated following 100 per cent correct responses on noncritical trials and following one or more errors.

The *S*s in Group 3 learned discrimination problems less well than *S*s in the other two groups.

The responses of *S*s in all three groups were greater to the category *Object and Position of A* than to the category *Object A*. This difference, although not large, is related to the properties of the former category. This category does not include responses which depend on differential position cues, and *S*s perseverate responses to position and object cues when responding to this category. If *S* made a response that was classified, *Object of A,* it had to make differential cue responses and choose between the formerly correct position and the formerly correct object. The data in this figure also indicate that naive *S*s were more influenced by position cues than were *S*s who had received more extensive training.

A comparison is made in Figure 4 of the percentage of responses that the *S*s in each group made to the combined categories, *Object of A* and *Object and Position of A* when the incorrect object was eliminated following non-

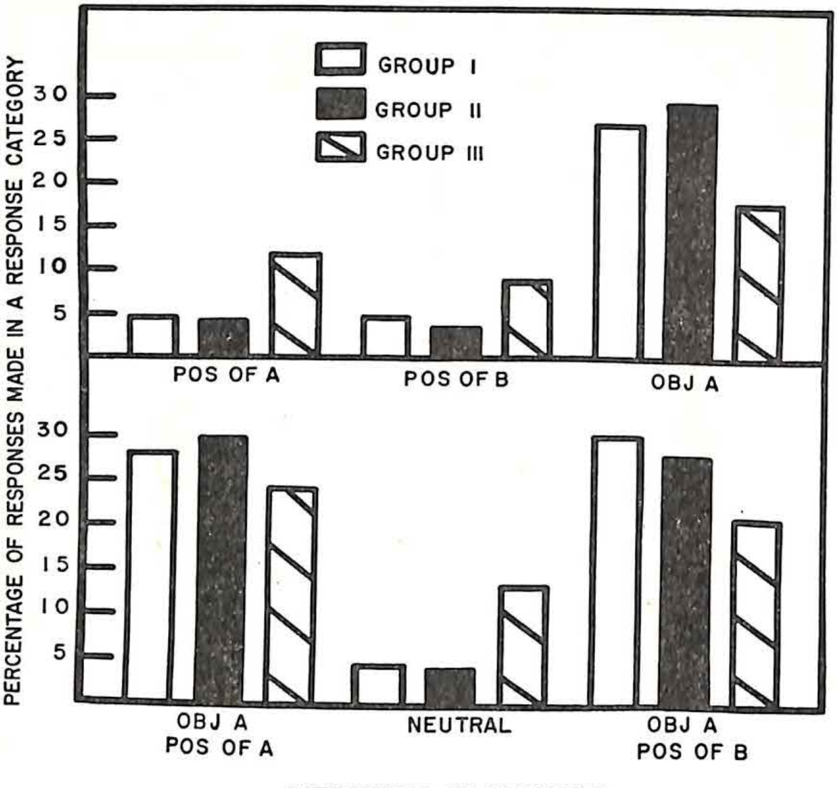

FIGURE 3

Performance of monkeys on insoluble critical trials (CTs) in which the *incorrect* object was eliminated. Group 1 = Old *S*s with prior irradiation. Group 2 = Old *S*s without prior irradiation. Group 3 = Young naive *S*s.

critical trials where no errors were made and where at least one error was made. This figure illustrates large group differences in selecting these categories.

The differences between performance following 100 per cent reinforcement of preferred objects and following one or more nonrewards of *S*s preference were significant using the mean difference *t*-test, $p < .01$ for the comparison involving *S*s in Group 1 (old irradiated *S*s) and $p < .05$ for the comparisons using *S*s in Group 2 (old nonirradiated *S*s) and Group 3 (naive *S*s).

A further comparison was made between the categories selected by *S*s following one and following several noncritical trials. Repetition of noncritical trials significantly increased the likelihood that *S*s would make object preference responses and decreased the likelihood of position preference

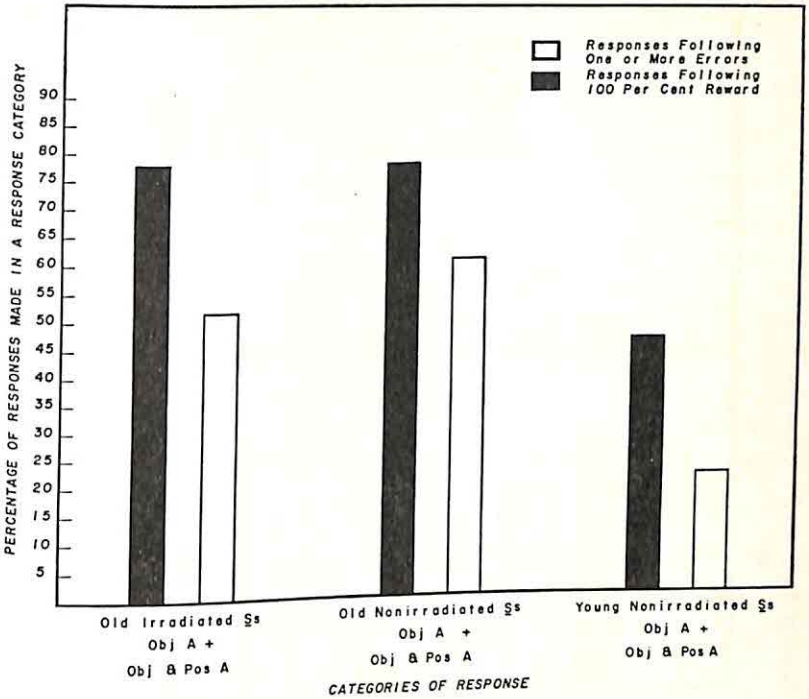

FIGURE 4

Performance of monkeys on the combined correct object categories of insoluble critical trials following all correct noncritical trials and noncritical trials on which errors occurred.

responses and these differences apply to the data obtained under both of the conditions of eliminating objects.

D. DISCUSSION

Rhesus monkeys have consistent preferences for foods (3) and objects that are not food (1). The preferences of monkeys for objects on discrimination problems are ignored or considered something that takes place after a reward or nonreward, and *S*s' performance is viewed from *E*s' arbitrary criterion of correct or incorrect.

The effect of *S*'s initial preferences are totally obscured in discrimination problems since the same pair of stimuli is present on every trial. If a single object is presented on Trial 1 and either rewarded or not rewarded, *S*'s preference is not expressed until after *E* has indicated the correct or incorrect object to *S*.

In the present experiment, *S* made an initial choice between two objects, and *E* determined whether or not the object that was preferred was rewarded or not rewarded, and, on a subsequent critical trial *E* could determine whether the preferred, nonpreferred, rewarded, or not rewarded object was selected from alternative objects present.

When *E* designated an object as correct on noncritical trials and *S* preferred this object to its alternative, there was a very high probability that the object would be selected if paired on a critical trial with three neutral objects, and the probability of its selection was higher among sophisticated than naive *S*s. However, if *S*'s preference for the object did not coincide perfectly with its being correct the probability that it was selected on critical trials was considerably less (re-examine Figure 4.) These results corroborate the first study using the technique of reducing cues by adding alternative stimuli (2).

A comparison between the first and third figures indicates that the object designated incorrect on a noncritical trial was not as likely to be selected on a critical trial as the object designated correct. However, it was selected on a critical trial more frequently than a neutral stimulus occupying a neutral position and the second figure indicated that its selection was independent of *S*'s preference on noncritical trials. These findings clearly show that an object acquired preference merely by being present on noncritical trials. Furthermore, object preference increased as a function of the number of noncritical trials in spite of the absence of differential position cues and nonreward of *S*s' preference on one or more trials. This finding agrees with Leary's statement that presentation of unselected negative objects increases their attractiveness (4, p. 95).

The tendency of an object to acquire preference without reward was more characteristic of sophisticated than naive monkeys and more characteristic of *S*s that were not irradiated than *S*s surviving irradiation. The first of these findings is undoubtedly related to the strong preference of naive *S*s for the positions formerly occupied by the reward (see *Position of A* in Figure 1). The second finding corroborates an earlier experiment (2) which shows that *S*s in the nonirradiated group have a stronger preference on critical trials for the *B* object than alternative incorrect objects. The present findings do not substantiate the earlier findings that preference of the *A* object on noncritical trials enhances selection of the *B* object on critical trials.

E. SUMMARY

Fifteen rhesus monkeys were employed in an experiment designed to study the relationships between object preferences, position preferences, and

rewards on the performance of *S*s on critical trials. One of the objects present on noncritical trials was eliminated on critical trials and *S* chose between the remaining object and objects other than the one previously correct or incorrect.

1. If the object preferred on noncritical trials was rewarded *S* selected this object from three other objects on about 75 per cent of the critical trials.

2. If the object chosen on all noncritical trials was incorrect *S* selected the unchosen correct object on about half of the critical trials.

3. Nonrewarded objects were preferred to neutral objects on critical trials when the rewarded object was missing. This preference increased as a function of practice on noncritical trials and was greater in nonirradiated *S*s than in *S*s with a history of irradiation.

4. The position of the chosen correct object was favored more by naive *S*s than by sophisticated *S*s.

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RELATIONSHIP BETWEEN EMOTIONAL ELIMINATION, STARTLE RESPONSE, AND BLOOD COUNT AFTER STRESS*

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A. Problem

The susceptibility of the rat to emotional disturbance has been measured in a number of ways. The open field test of emotionality originally developed by Hall (1934) has been used a great deal as a dependent variable and recently has been studied extensively by Broadhurst (1957, 1958). The startle response has also been used, although somewhat less frequently (Brown, 1951). Psychologists have given relatively little attention to blood changes which result from emotion producing stimuli.

In 1938 Farris (1938) reported that there was an increase in the lymphocyte count in the rat after 5 min. of restraint. More recently, Wenger (1943) has failed to find lymphocytosis in human children. In fact, his results are opposite in direction to those reported by Farris. A number of experiments have shown that eosinopenia follows stress. Anthony, for example, demonstrated that noise stress produces moderate eosinopenia in normal mice and marked eosinopenia in seizure-susceptible mice (1955).

Although Moyer (1957) showed that there appears to be no relationship between emotional elimination and the persistence of an anxiety motivated response, further work seems indicated in an effort to determine whether or not some of these measures of emotionality covary in the same *S*.

It is the purpose of this study to determine the correlations among these indicants of emotionality: emotional elimination, startle response, and eosinophil and lymphocyte counts taken before and after stress.

B. Method

1. *Subjects*

In this study 40 naive, female, hooded rats from the colony of the Carnegie Institute of Technology were used. All *S*s were between 100 and 115 days of age at the time of testing.

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2. *Apparatus*

The open field apparatus consisted of a table top covered with white oil cloth. It was 23 × 33 in. with sides of composition board painted gloss white 15 in. high. A 200-watt light bulb was placed 23 in. above the table, and the table top was 29 in. above the floor.

For the stress situation, the rat was held in an adjustable rat holder manufactured by the Stoelting Company. Shock was administered by an electronic shocker with sufficient resistance built into the circuit to minimize individual resistance differences in the *S*s.

The startle apparatus has been described in more detail elsewhere (Moyer and Bunnell, in press). Briefly, it consisted of a sensing unit made from a postage scale (Hanson Model 1509 5-lb. capacity). The platform was replaced with a confining box. When a *S* was placed in the confining box and subjected to a sharp auditory stimulus, the startle reaction of the animal caused the platform to be depressed. The downward movements of the platform were transmitted by a thread and pulley system to a lever recording pen on a Phipps and Bird recorder. The startle stimulus was produced by a toy pistol (Super Nu-Mater Paper Buster Gun) held 6 in. over the confinement box.

3. *Procedure*

The procedure was exactly the same for all *S*s. Three blood samples were taken at 3-day intervals to establish a base differential leucocyte count. The blood was obtained by slicing the tip of the tail while the rat was held in light restraint. The time of day the samples were drawn—early afternoon—was held constant.

Three days after the third blood sample was taken, the open field test was initiated. Each animal was placed in the center of the open field for a 4-min. period once a day for 7 days. A record was kept of the number of fecal bolli produced and the days on which the *S* urinated. Between trials the sides were removed and the oilcloth washed with warm water and allowed to dry.

On the day following the last emotional elimination trial the startle response was measured. The *S* was placed in the confinement box of the startle apparatus and was given 15 sec. to acclimatize to the box while the pen of the recorder was being adjusted. The paper buster gun was then held 6 in. above the cage and fired. The *S* characteristically ceased all random movements and remained quite still on all four feet in the box, and did not change position appreciably during the rest of the trial. Five more shots were fired at intervals of 23 sec. and the magnitude of the startle response automatically recorded.

Shock stress was administered on the day after the startle response was recorded. The *S* was placed in the Stoelting holder and coiled spring electrodes attached to the tail. Five 1.5 milliampere shocks of 15 sec. duration were administered at 1-min. intervals with the constant current shocker. The shock was sufficiently strong to cause all animals to struggle violently, and squeal. Five to 10 minutes after the shock was discontinued, the final blood sample was taken according to the procedure described.

C. RESULTS

The blood smears of five of the 40 *S*s had to be discarded because of improper staining and all data involving blood count is based on an *N* of 35. The median of the three counts taken before the start of the experiment was used in computing the mean *basal* eosinophil and lymphocyte counts. The mean base eosinophil count was 3.85 per cent. The mean of the eosinophil count after stress was 2.05 per cent. A Bartlett's test of the data showed that the variances for the two conditions were not significantly different, $\chi^2 = .64$. A *t*-test indicated that the difference between the two means was significant beyond the .001 level of confidence, $t = 6.28$. The mean of the median base lymphocyte count was 58.84 per cent, and the mean of the lymphocyte count after stress was 76.68 per cent. A Bartlett's test was not significant, $\chi^2 = 5.8$. The *t* test was significant at the .001 level of confidence, $t = 13.65$.

As a check on the extinction of the startle response over the five recorded startle trials, the data on the first measured startle response was compared with the data for the last response for all 40 animals. A significant Bartlett's test, $\chi^2 = 13.08$, precluded the use of the *t* test. The non-parametric sign test indicated that the difference was significant beyond the .001 level of confidence (Walker and Lev, 1953). The correlations between the experimental variables for $N = 35$ are presented in Table 1.

D. DISCUSSION

The results demonstrate that lymphocytosis and eosinopenia are apparent in the stressed rat. These results support the work of Farris (1938a, 1938b) and Anthony (1955), and suggest further experiments aimed at determining the precise relationship between blood counts and the physical magnitudes of presumed stressors. Once defined, these relationships may provide psychologists with a convenient measure of stress—at least in the rat—for use in

TABLE 1
Table of Intercorrelation (N = 35)

1	2	3	4	5	6	7	8	9	10	11	12	13	14	
.44	.43	—.03	—.16	—.06	*—.34*	—.11	—.32	.08	.18	.10	.12	.03	1	Med Eosinophile
	—.62	.10	—.20	—.19	—.19	—.15	—.19	*.37*	*.57*	*.44*	*.45*	.26	2	Stress Eosinophile
		—.13	.06	.14	—.11	.05	—.09	—.31	*—.41*	*—.35*	*—.35*	—.23	3	Difference Eosinophile
			.01	—.84	.12	.01	.00	*.50*	.26	.29	.25	*.35*	4	Median Lymphocyte
				.54	—.11	.04	—.12	.12	—.17	—.05	—.03	—.14	5	Stress Lymphocyte
					—.16	.01	—.07	*—.36*	—.31	—.27	—.23	*—.38*	6	Difference Lymphocyte
						.51	.97	—.11	—.14	—.17	—.26	—.11	7	Days Defecated
							.53	—.08	.05	.06	—.04	.09	8	Days Urinated
								—.18	—.16	—.18	—.29	—.11	9	Mean E.E. Bolli
									.74	.65	.83	.66	10	Startle 1
										.63	.83	.61	11	Startle 2
											.70	.86	12	Startle 3
												.68	13	Startle 4
													14	Startle 5

experimental situations in which the magnitude of stress is not immediately apparent.

A comparison of first startle response scored with the fifth response indicates that there is a significant reduction in the magnitude of startle over a series of five trials spaced 23 sec. apart. This extinction of the startle response confirms a previous finding of Moyer and Bunnell (in press).

None of the correlations between the measures of emotional elimination and the startle responses are significantly different from zero. However, this group of rats manifested relatively little emotionality, nine of them receiving no score. With this much restriction of range, relatively low correlations might be expected.

The results indicate a relationship between blood counts and the startle response. Although there is no significant relationship between base eosinophil count and startle, the correlations between the eosinophil count after stress and the first four startle responses are significantly greater than zero. There are also significant relationships between the difference scores (differences between eosinophil count before and after stress) and three of the startle responses. The median pre-stress lymphocyte count correlates significantly with the first and last startle response as does the lymphocyte difference score. However, there appears to be no relationship between the lymphocytosis after stress and the startle response.

Evidently, some underlying physiological process contributes both to blood changes during stress and the magnitude of the startle response. It has been suggested that emotional lymphocytosis is a function of an increase of adrenalin in the bloodstream (Farris, 1938). The cause of the eosinopenia of stress is at best confused. Apparently eosinopenia can be brought about either by adrenalin or cortisone injections while a combination of the two results in a potentiation of their effects (Selye, 1956). It seems improbable that either of these functions of the adrenal could contribute to the magnitude of the startle response because of the rapidity with which the startle response follows the stimulus. Also, Moyer and Brunnell (in press) have already shown that exogenous adrenalin has no influence on the magnitude of the startle response. It may be, however, as Moyer and Bunnell pointed out, that exogenous adrenalin does not duplicate the action of endogenous adrenalin.

Whatever the nature of the mechanism involved, the direction of the significant correlations between post-stress eosinophils and startle indicates that those animals who give the largest response to startle show the smallest eosinopenic response to stress. In line with this, the negative correlations between difference eosinophils and startle indicate that small changes in eosinophils count are related to large startle responses, although it should be pointed out that these difference scores cannot be presumed to be independent of the basal scores.

It will be noticed that base lymphocyte count appears to be positively correlated with the startle response. It is possible that there is a constant level of adrenalin secretion which contributes to the control of the number of lymphocytes in the blood and that this adrenalin level varies from animal to animal. It is also possible that the magnitude of the startle response is in part a function of the hypothesized constant level of circulating adrenalin. If this is true, one might expect the magnitude of the startle response to decrease after adrenal demedullation. This possibility will be checked in the near future.

It seems more probable, however, that the physiological factor underlying both blood count changes and the startle response is more basic than adrenal action. This factor is difficult to specify without further research.

The negative relationships between difference lymphocytes and startle pose an additional problem in interpretation. In this case it is not known whether the association between a small change in lymphocytes and a large response to a startle stimulus might be a function of a lack of adaptability or whether it is due to those animals having a high initial level of lymphocytes being closer to a "ceiling" which limits the amount of increase in lymphocytes that can occur.

The only other significant correlation is between the base eosinophil count and number of days defecated in the open field. Inasmuch as this is the only significant correlation among the possible correlations between blood count and emotional elimination, the authors are reluctant to attempt any interpretation.

E. Summary

Forty female hooded rats were used in this study. All of the *S*s were subjected to the following procedures:

1. Three blood counts were made to determine a basal differential leucocyte count.
2. Emotional elimination was recorded in the open field test.
3. Five startle responses were recorded.
4. The *S*s were held in a restraining cage and subjected to shock stress. In the stress situation, five shocks of 1.5 milliamperes of 15-sec. duration were administered to the tail. Five to ten minutes after the shock stress a fourth blood-sample was taken.

The results show that both eosinopenia and lymphocytosis follow stress

in the rat; that the startle response is significantly reduced in five trials, and that the startle response correlates significantly with per cent eosinophils after stress, the difference between pre- and post-stress per cent eosinophils after stress, the basal per cent lymphocytes, and the difference between the pre- and post-stress per cent lymphocytes.

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DIFFERENTIAL EFFECTS OF IONIZING RADIATION UPON "ABSOLUTE" AND "RELATIONAL" LEARNING IN THE RHESUS MONKEY*

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A. PROBLEM

The present investigation was undertaken to compare the effects of ionizing radiation upon two types of learning in rhesus monkeys. Psychological literature is filled with controversy concerning the nature of discrimination learning among inarticulate organisms. Gestalt psychologists have traditionally contended that discrimination performance depends upon the learning of relationships between stimuli (3, 7, 8, 9, 10). S-R theorists contend that it is not necessary to employ perceptual, relational concepts in accounting for the learning of simple discriminations. This group of theorists assumes that the organism learns by associating simple responses with absolute stimulus properties (16, 17, 18). The present investigators assume that monkeys are capable of both "absolute" and "relational" learning (2, 4), and the present experiment was undertaken to determine whether the two types of learning are equally affected by exposure to ionizing radiation.

An experimental paradigm first employed by Gonzales, Gentry, and Bitterman (5) to demonstrate the existence of "relational" learning among chimpanzees was used in this investigation. As far as the present investigators know, no one has contended that this experimental design does not indeed test the tendency toward relational learning. The subjects are first trained to choose the intermediate of three different size stimulus objects. Solution of this discrimination problem can be achieved by associating a response with an absolute size of the positive stimulus or by learning the size-relationships between the stimuli. However, when the absolute sizes of all stimulus objects are shifted during the test for transposition, above chance preference for the intermediate-size stimulus can only be explained in terms of the learning of stimulus relationships. If irradiated and non-irradiated subjects perform equally well during original discrimination learning, but then perform differently on tests for transposition, it must be concluded that they were learning different things.

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B. Method

1. *Subjects*

Thirty-three rhesus monkeys (Macaca mulatta) were subjects in this experiment. They were divided into five groups according to radiation exposure. Group I was composed of eight non-irradiated control animals. Group II included five chronic, whole-body irradiated animals which had received a total dose of 77 rep of mixed gamma-neutron radiation. Group III was composed of seven animals which had been exposed to 154 rep from the mixed gamma-neutron source. Group IV included nine animals previously exposed to 308 rep, and Group V contained four animals previously exposed to 616 rep from the mixed gamma-neutron source. All subjects were approximately five years of age, and radiation exposures had been completed on all animals about three years before the start of the experiment. Although the animals had been employed on a variety of discrimination problems, they had not received previous training in the apparatus nor on the type of problem discussed here.

2. *Apparatus*

A string-pulling apparatus was employed throughout the experiment. The subjects remained in 14 x 18 x 14 inch carrying cages during testing. Three stimulus objects, differing in size as described below, were set in grooved alleys at a distance of 31 inches from the subject. The stimulus objects were five inches apart from center to center, with a string leading from each object to the carrying cage of the animal. Each stimulus object was an open-top box, painted black, in which reward could be placed. The subjects were able to investigate the contents of the boxes by drawing them into reach by use of the attached strings.

3. *Procedure*

The experiment consisted of three phases—an easy discrimination with the intermediate-size stimulus positive, a difficult discrimination with the *same* intermediate-size stimulus object positive, and a test of transposition.

Each animal was trained first to a criterion of 16 out of 18 correct responses on Problem I—Boxes 1, 5 (positive), and 9 (ratio of areas 1: 1.75). There were 18 trials per day employing the correction method; if, on any trial, the first choice were incorrect, the animal was permitted to make a second and, if necessary, a third choice until the box containing the food reward was chosen to terminate the trial. The left, right, or central position of reward was systematically varied.

After each animal reached the criterion on Problem I, it was trained in the same manner and to the same criterion on Problem II—Boxes 3, 5 (positive), and 7 ratio of areas (1:1.32).

In the final stage of the experiment the animals were tested with each of two new sets of stimuli—2, 4, 6 and 4, 6, 8. The ratio of areas in each of these sets was the same as in Problem II (1:1.32), but the absolute sizes of all three stimuli in each test set were shifted by the ratio 1:1.15 from the values of corresponding stimuli in the training set. Thus, in test Set 2, 4, 6 the intermediate-size stimulus had an area half-way between those of Stimuli 3 and 5 of the training set, and in test Set 4, 6, 8 the intermediate-size stimulus had an area half-way between that of test Stimuli 5 and 7. Eighteen trials were given each day for four days. Of these, 12 were differentially reinforced trials with Boxes 2, 5 (positive), and 7—a continuation of training on Problem II. Systematically interspersed among them were six testing trials—three involving Stimuli 2, 4, 6 and three involving Stimuli 4, 6, 8—in which any choice was rewarded. In the four days of testing, each testing set was presented 12 times, twice in each of the six possible spatial arrangements.

C. Results and Discussion

The test of transposition is the number of choices of the intermediate-size stimulus. If the subject has associated a response with the absolute properties of the middle-size stimulus, maximum excitatory potential should be developed about stimulus No. 5, and a generalization gradient of decreasing value should extend to the stimuli on either side. Thus, on test trials, Stimuli 4 and 6 which were equidistant along the hypothetical generalization gradient should evoke equally strong response tendencies. On the other hand, if the subject has learned the relations between stimuli, then the stimulus (4 or 6) which appears intermediate in size in its test configuration (2, 4, 6, or 4, 6, 8) should be chosen significantly more often than the noncentral stimulus (4 or 6). The degree of relational learning is indicated by the degree to which choice of the intermediate-size stimulus exceeds the chance level. Since neither the "absolute" nor the "relational" prediction would involve choice of the noncentral Stimuli 2 and 8, chance performance should result in approximately 50 per cent choice of the intermediate-size stimulus on test trials.

The numbers of errors, or failures to choose the intermediate-size stimulus, was recorded for each subject. Figure 1 presents the mean errors on trans-

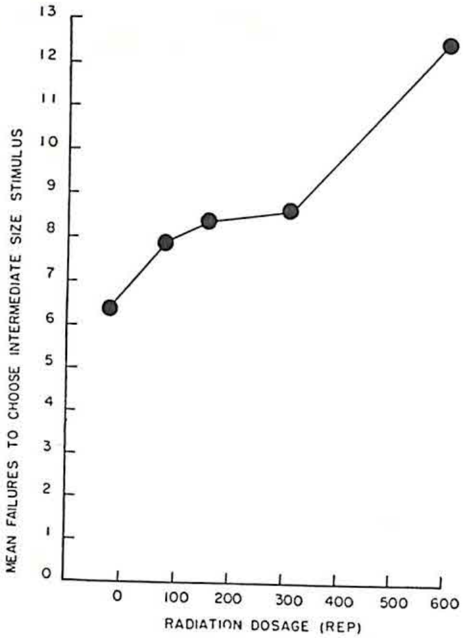

FIGURE 1
FAILURES TO CHOOSE THE INTERMEDIATE SIZE STIMULUS AS A FUNCTION OF RADIATION DOSAGE

position test trials for subjects of the five irradiation groups. Control animals which had received no radiation made an average of 6.4 errors on the 24 test trials. Low dose irradiated subjects which had received only 77 rep averaged 8.0 errors, and those which had received 154 rep averaged 8.3 errors out of a possible 24. Subjects previously exposed to 308 rep averaged 8.6 errors, and subjects of the high dose group which had received 616 rep made an average of 12.5 errors out of a possible 24.

An analysis of variance for the difference between group means yielded an F value of 6.59 which is significant beyond the .05 level. No significant between-groups variance remained after the portion associated with linear regression (91 per cent) was removed. Table 1 presents a summary of the analysis of variance performed on the data.

A number of experiments have produced evidence that irradiated subjects perform in a superior fashion on certain types of problems (11, 12, 13, 14, 15). It is possible to account for the learning in each of these instances in terms of a simple, mechanistic association of response with absolute stimulus properties. In an experiment by Harlow and Moon (6), irradiated monkeys indicated a *relative* facilitation on oddity learning set

TABLE 1
SUMMARY OF ANALYSIS OF VARIANCE

Source	df	SS	MS	F
Between dose groups	4	101.12	25.28	3.21*
Linear regression	1	92.02	92.02	11.68**
Deviations from linear regression	3	9.10	3.03	.39
Within dose groups	28	220.52	7.88	
Total	32	321.64		

* Significant beyond .05 level.
** Significant beyond .01 level.

problems. However, close examination of the learning curves indicates no absolute facilitation for the irradiated subjects. Instead, normal animals appear to suffer interference on certain of the later problems. McDowell (11) suggests that these results are consonant with the hypothesis of decreased distractability among irradiated subjects and may have resulted from greater "boredom" on the part of the normal animals.

The task presented to the subjects in this experiment could be solved either by learning relations between the stimuli or by associating a response with absolute stimulus properties. Those subjects which solved the initial discrimination by associating a response with absolute stimulus values should perform at or near the chance level on transposition test-trials, and subjects who learned relationships between the stimuli should continue to choose the intermediate-size stimulus on test trials. The results indicate that the tendency to learn relationships between the stimuli decreased as a linear function of radiation dosage. This finding supports the hypothesis that facilitated learning by irradiated subjects, where it has been found, has resulted from a restriction of attention to the specific properties of the rewarded stimulus and that this focalization of attention has resulted in relative inattention to relationships between stimuli. It is not suggested that irradiated subjects cannot learn stimulus relationships when these are necessary for problem solution. On the contrary, they have demonstrated efficient performance on a variety of experimental tasks involving relational learning (1, 6). What is suggested is that, when given the opportunity, irradiated animals utilize the simpler form of learning to a greater extent than normal animals.

D. SUMMARY

Thirty-three rhesus monkeys, representing five radiation dose levels, were trained on intermediate size discrimination problems. A test of transposition was employed to determine the extent to which subjects of the different

dose groups utilized relationships between the stimuli as a basis for problem solution. Relational learning was found to decrease as a linear function of radiation dosage.

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SOME EFFECTS OF RADIATION EXPOSURE ON SUSCEPTIBILITY TO PROACTIVE INHIBITION BY RHESUS MONKEYS*

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A. Problem

Warren, Kaplan, and Greenwood (5) have reported a significantly superior performance by normal monkeys over irradiated monkeys on the solution of discrimination reversal problems. McDowell and Brown (3) have found, in contrast, that irradiated monkeys show significantly smaller negative savings scores than normal monkeys on an oddity-reversal problem. This finding suggests a facilitation accruing to the irradiated animal with respect to utilization of the same stimulus cues in antagonistic response patterns.

The present study was undertaken to compare the response perseveration of the irradiated monkey with that of the normal monkey when tested according to the proactive inhibition paradigm. That animal with the greater response perseveration should show the greater susceptibility to proactive inhibition. The study specifically involved the effects of initial training on a peripheral cue discrimination problem, during which no learning was manifest, on the subsequent transfer of a single learned discrimination along a peripheral cue gradient.

B. Methods

1. *Subjects*

Twenty-four male rhesus monkeys, ranging in age from 5¼ to 6¼ years, served as *S*s. The training histories of the *S*s were roughly identical and included a wide array of discrimination tasks, delayed response training, tests of psychomotor coordination, patterned-string performance, food-preference studies, and visual acuity problems. None of the *S*s had experienced previous training on the utilization of peripheral cues to obtain food rewards.

Twenty-one of the *S*s were normal. The remaining three *S*s had previously been exposed to a mixed source of gamma and neutron radiation

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approximately three years before the present study was initiated. They had received a total whole-body radiation dose of 308 rep.

2. *Apparatus*

All testing was conducted in a modified version of the Wisconsin General Test Apparatus (WGTA), the holding cage of which measured 36 x 30 x 24 inches. A grey painted stimulus tray holding two foodwells, spaced 12 inches apart center-to-center, was used in the direct-response discrimination training.

A modified 2-string patterned string board (2) was used for all peripheral cue testing. This string board was placed directly over the stimulus tray used in the direct-response discrimination training. The strings, pieces of plumber's chain, were attached in the front of the board to seated eyebolts and extended to behind a 3-sided chimney in the rear center of the board. Small nails attached to the free ends of each length of plumber's chain were used to impale the food reward, a raisin, on the end of the appropriate chain. The 3-sided chimney prevented the *S* from response on the basis of seeing which chain held the raisin. The peripheral cue positions were measured along the back of the board from the chimney to the edge of the board. The distances from the inner edge of the peripheral cue to the edge of the 3-sided chimney were, from closest to remotest peripheral cue positions respectively, 1.125 inches, 3.375 inches, 5.625 inches, and 7.875 inches.

The stimulus objects for the original peripheral cue discrimination training were two triangular (isosceles triangle) wooden blocks, each with a base of 2¼ inches, an altitude of 4⅝ inches, and a thickness of 1⅝ inches. The positive block was painted orange and the negative block green.

The negative stimulus object for testing the transfer of a single learned discrimination along a peripheral cue gradient was a black painted circular wooden block measuring 2⅜ inches mounted flat on a white painted square wooden block measuring 3 × 3 × ⅝ inches. The positive stimulus object was a red painted triangular (isosceles triangle) wooden block with a base of 2¾ inches, an altitude of 2½ inches, and a thickness of ⅝ inches mounted vertically on a red painted square wooden block measuring 3 × 3 × ⅝ inches.

3. *Procedure*

Four normal and the three irradiated *S*s were initially tested 25 trials per day for 30 days on a peripheral cue discrimination problem with the discriminanda being placed for each trial in the most peripheral positions on the modified string board. The discriminanda for this testing were the orange and green painted triangular wooden blocks.

Following the initial training of the four normal and three irradiated *S*s, each of the 24 *S*s was tested 24 trials per day for five days on a single discrimination problem involving direct manual response to the wooden blocks covering the two foodwells on the two foodwell stimulus tray. Then, each *S* was tested 24 trials per day for five days on each of the four peripheral cue conditions, the order of testing being from the least peripheral to the most peripheral condition. This task required a manual response to a length of plumber's chain on the basis of the proximity of that chain to the stimulus object which had been rewarded in the simple discrimination training. The order of occurrence of randomly and constantly arranged blocks was randomized in the 24 trials presented to each *S* each day.

A simple discrimination training trial was presented in the following manner. The opaque screen of the WGTA was lowered, ending the previous trial, and the two foodwell stimulus tray was cleared. One raisin was placed in either the right or left side foodwell according to the predetermined random order. The two wooden blocks were placed simultaneously over the two foodwells, the positive block, of course, being placed over the foodwell containing the raisin. The 1-way vision screen was lowered, the stimulus tray carrier advanced, and the opaque screen raised, allowing the *S* to make a choice. After the *S* completed the trial, the stimulus tray carrier was withdrawn from the reach of the *S*, the opaque screen lowered, and the next trial commenced. The *S* was allowed only one choice on each trial.

The peripheral cue testing differed from the simple discrimination training only in that the food reward was impaled on the end of a length of plumber's chain and hidden behind the 3-sided chimney in the rear center of the modified string board and in that direct manual response to the length of chain on the side of the board holding the positive object of the simple discrimination training was rewarded rather than direct manual response to the object itself.

C. RESULTS

Figure 1 shows the per cent of errors for successive 5-day blocks of training on the peripheral cue discrimination trials given to four normal and three previously irradiated monkeys. Statistical analysis of the error data, using a groups-by-practice analysis of variance design, yielded (*a*) no significant difference between groups and (*b*) no significant improvement in performance with practice.

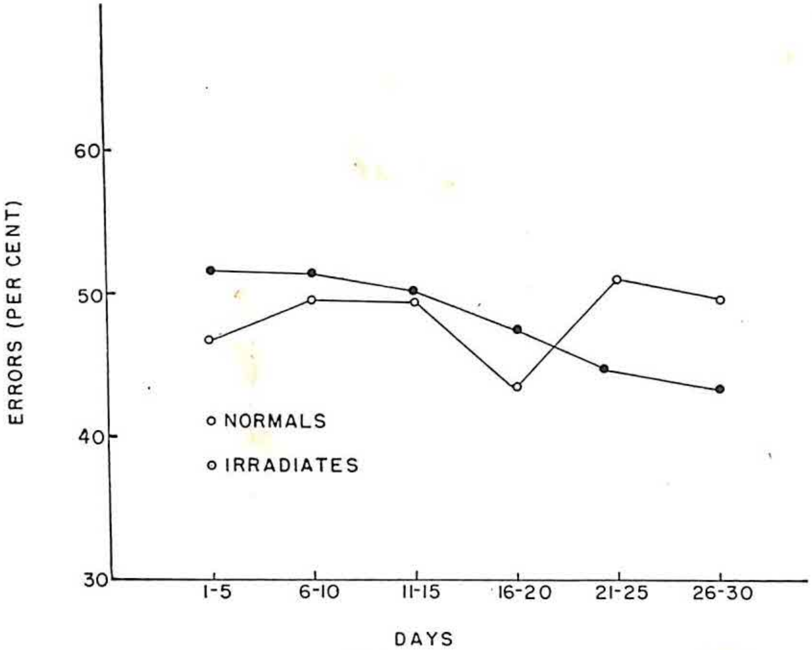

FIGURE 1
PER CENT OF ERRORS PER GROUP FOR SUCCESSIVE FIVE-DAY BLOCKS OF TRAINING ON A PERIPHERAL CUE DISCRIMINATION PROBLEM

Figure 2 shows the per cent of errors for the pre-trained normal monkeys, pre-trained irradiated monkeys, and normal monkeys on the simple discrimination training and on each of the four peripheral cue conditions. In Figure 2, the first condition is the simple discrimination problem, and Conditions 2 through 5 are the peripheral cue conditions from nearest to remotest, respectively.

The three groups did not differ significantly with respect to errors on the simple discrimination training, as compared using a simple randomized analysis of variance design. Statistical analysis of the error data over the four peripheral cue conditions, using a groups-by-conditions analysis of variance design, yielded (*a*) a difference between groups which was significant beyond the 0.5 per cent confidence level, (*b*) a difference between conditions which was significant beyond the 5.0 per cent confidence level, and (*c*) a groups-by-conditions interaction which was not statistically significant.

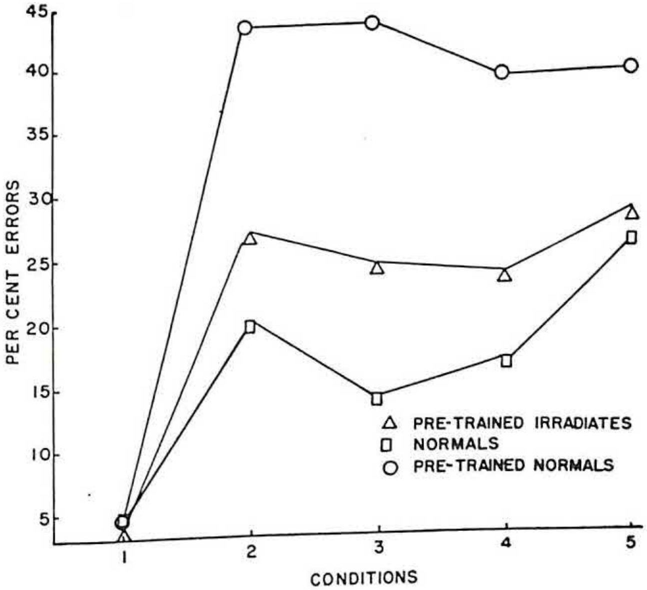

FIGURE 2

Per Cent of Errors for Pre-Trained Normal *S*s, Pre-Trained Irradiated *S*s, and Normal *S*s (without pre-training) on the Direct-Response Discrimination Training and on Each of the Four Peripheral Cue Conditions

D. Discussion

The results of the present study are considered to indicate that the chronic irradiated male monkey, at least at the dosage used, is less susceptible to proactive inhibition than is the normal male monkey. Initial training on a peripheral cue discrimination problem, training during which no learning was manifest, interfered less with the subsequent transfer of a single learned discrimination along a peripheral cue gradient by the chronic irradiated *S*s than by the normal *S*s.

The proactive effect appears to have been due to failure to learn the initial problem. The consequence of the failure to learn the initial discrimination was apparently an association of the stimulus events of peripheral cue testing with a 50.0 per cent reinforcement schedule. An hypothesis of decreased distractibility (1) and a narrowed scope of attention (4) for the irradiated animal would predict that fewer stimulus events would be associated by the irradiated animal than by the normal animal. Any change, then, in one of the stimuli associated by both normal and irradiated monkeys would constitute a proportionately greater alteration of the situation for the irradiated animal. Thus, the irradiated animal should more easily discriminate a change in the situation and redefine the problem, as was the case in the present study.

E. SUMMARY

Four normal and three previously irradiated male rhesus monkeys were first extensively tested in a peripheral cue discrimination problem. Then, these seven *S*s and 17 normal monkeys, which had not experienced the pre-training, were tested for transfer of a single learned discrimination along a peripheral cue gradient. The following results were obtained:

1. No significant improvement in performance was manifest by either normal or irradiated *S*s during extensive training on the peripheral cue discrimination problem.

2. The pre-trained normal *S*s, pre-trained irradiated *S*s, and normal *S*s did not differ significantly with respect to errors on the direct-response single discrimination training.

3. The three groups did differ significantly with respect to errors when tested for transfer of the single learned discrimination along a peripheral cue gradient. The pre-trained normal *S*s manifested the greatest number of errors and the normal *S*s the least, indicating that the chronic irradiated male monkey, at least at the dosage used, is less susceptible to proactive inhibition than is the normal male monkey.

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AGE CHANGES IN THE RORSCHACH RESPONSES OF A GROUP OF ELDERLY INDIVIDUALS*

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A. Introduction

An earlier study of the Rorschach responses of 200 elderly persons (70 years of age and older) suggested that responses of older people appear to fall into one of three categories. Some, regardless of advanced chronological age, still give a response as intact, as rich, and as varied as that of the normal mature adult. Others, whose response has deteriorated conspicuously may be identified as senile. Special characteristics of senility are a response in which the A% or the anatomy per cent, or both together, is close to 100 per cent, with a very high F% and a very low F+%, and often with static perseveration (4).

The majority of responses of 70-100 year old people fall between these two extremes, into a category which we have defined as presenility. Presenile subjects, by no means as yet senile, nevertheless differ significantly in their response from what is expected of the normal adult. Quantitative scoring signs are chiefly high A% and high F%, low F+%, low number of responses, and little variety of content. In addition, presenile subjects show specific qualitative signs of aging. Such signs may be classed in two groups—those which occurred in children's records but not in records of normal adults, and those which do not occur conspicuously in records of either children or of mature adults. These we have identified as A-list signs and B-list signs respectively.

The records of extremely well preserved old people, regardless of age in years, thus often resemble in most respects those of normal adults. Others by falling into the presenile category, show some deterioration. Still others, which can be classed as senile, show marked deterioration. It appears possible on the basis of Rorschach test responses to determine the degree of intactness or of deterioration of the psyche of the elderly individual.

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In many respects the change which takes place with increasing old age seems to be the reverse of changes which take place between childhood and adulthood. As the individual deteriorates, his Rorschach response becomes increasingly like that of a younger and younger person.

However, in this age sector of life as at earlier ages, it is important to know not only what kind of response an older person gives at any certain time, but also in what ways and to what extent his response changes with age. For our first study of age changes in the older person (4) only eight re-test subjects, ranging in age from 72 to 99 years at the time of the second test, were available—each tested after a 2-year interval. In this small group, for the most part the second tests as compared with the first showed increased W%, F%, A%, A- and B-list signs, and decreased N, F+%, M and FM, color, variety of content, F(C). However, not every subject showed changes in the expected direction for all determinants.

The present study reports age changes in 61 over 70-year-old subjects each retested on the Rorschach after approximately a four-year interval. Its purpose is, by comparing a first and second test on the same individual, to determine the nature, extent, and direction of age changes both in individual subjects and in the group as a whole.

Earlier studies (3, 5) have suggested that conspicuous and characteristic age changes take place in the Rorschach response in the years from two through 16 years of age. Investigations now under way are checking age changes in groups of subjects between the ages of 18 and 22 years, and of subjects in their thirties, all being tested annually. However though some longitudinal studies have appeared in the literature (10, 16) we have as yet no clearcut evidence which tells to what extent the Rorschach response changes throughout the total life span. Nor, though several studies of Rorschach responses in old age have been reported, notably by Klopfer (12), Prados and Fried (18), Chesrow, Wosika, and Reinitz (6), Dörken and Kral (8), Grossman, Warshawsky, and Hertz (9), Kuhlen and Keil (13), are there available any longitudinal studies for checking what happens to individual Rorschachs in very old people, with increasing age.

B. Subjects, Methodology and Scoring

Subjects for the present study are 61 elderly individuals all over 70 years of age, on whom two Rorschach tests with a mean interval of from 4 to 5 years were available. These subjects included all of an original group of 200 who were still alive, reasonably clear in their minds, and willing to take a second test.

Three somewhat different populations were included. A group of 9 subjects, termed the New Haven group, all lived independently in their own homes. A second group of 16 were inmates of the Victoria Home for Aged British Gentlewomen at Ossining, New York. The largest group, 36, were inmates of the Masonic Home in Wallingford, Connecticut. Both of these homes offered accommodations considerably above the typical institutional standard.

Subjects outside the institutions were originally chosen as being reasonably healthy, active, and alert. None were bedridden. Institutional subjects were selected as being, in the opinion of the institution's personnel, alert and capable and "able to look out for themselves."

Thus our main criteria for selection of subjects were age and availability. These criteria being met, we screened out those individuals so grossly incompetent or aberrant in behavior as to suggest senile dementia. Sex of subjects, and their age at the time of first examination are given in Table 1. All 16 Victoria Home subjects were given a second test five years after the first. All 36 Masonic subjects were tested for the second time after an interval of four years. The nine New Haven subjects were seen at intervals ranging for different subjects from two to six years—the mean interval for the group was 4.4 years. Thus for the group as a whole the interval between first and second tests was in most instances between four and five years.

TABLE 1

DISTRIBUTION OF SUBJECTS BY AGE AND SEX AT THE TIME OF FIRST EXAMINATION

Age	Females	Males	Total
70	27	6	33
80	16	5	21
90	6	1	7

1. *Socio-Economic Status*

A large cluster of different specific items of information about individuals—their education, occupation, income level, social class, community status—are commonly grouped under the general heading of socio-economic status (SES). Since an individual's status partly derives from his own ability level, and partly determines the extent and types of contacts he has with his environment, some index of this status is generally found to bear a relationship to most psychological functions measured in the ability and personality fields.

Because of the high degree of interrelationship among the various items in this cluster, any single item generally serves as a fairly satisfactory estimate for the total complex. For our old people we have gathered information on the two most accurately classified and commonly used indices of SES: level of education and level of occupation in earlier life (husband's occupation in case of married women). These indices tend to stress the ability aspect of SES, and provide a rough estimate of the range of intelligence of our sample. For purposes of comparison, we include a tabulation of the same data for the total U.S. population in this age range and geographic area, computed from the total U.S. Census data (20). Occupation is classified on the Minnesota Scale of Paternal Occupations (11).

From Tables 2 and 3, which follow, it will be seen that subjects of nearly all levels of social status and ability were included in our sample, but that those of higher levels are overly represented in comparison with the total U.S. population. Studies of Miles and Miles (14) and Owens (15) have suggested that individuals with higher ability or educational level

TABLE 2

(Compared with Years of School for White Population Currently Aged 72-86 Years, Calculated from 1940 Census)

Years of education	Level	No.	Percentage Total sample	Census
0—7	Grammar School, under 8th grade	0	—	37%
8	Grammar School, graduate	13	21%	37%
9—11	High School, 1-3 years	5	8%	8%
12	High School, graduate	13	21%	9%
13+	College, Normal School, 1st year or beyond	24	39%	6%
	Unclassified	6	10%	3%

TABLE 3

Occupational Levels

Men's Own and Women's Own or Husband's Occupations on the Minnesota Scale, Compared with the 1920 U.S. Census Data (When Current Population Was Aged 38 to 57 Years)

Class	Type of Occupation	No.	Percentage Total sample	Census
I.	Professional	8	13%	3%
II.	Semi-professional, managerial	17	28%	5%
III.	Clerical, skilled, retail business	12	19%	14%
IV.	Farmers	—	—	19%
V.	Semi-skilled, minor business	17	28%	27%
VI.	Slightly skilled	4	7%	13%
VII.	Day laborers	—	—	19%
	Unclassified	3	5%	—

at younger ages tend to "hold up" better in psychological performance in old age.

2. *Methodology and Scoring*

Details of methodology and scoring will be found in our report of the first testing of these subjects (4, p. 18-22). Methodology did not differ conspicuously from the ordinary giving of the Rorschach test, except that much special encouragement and enthusiasm were needed. Best results were obtained by looking directly at the subject, praising him, answering all questions, listening to his stories, immediately responding to his remarks. No additional inquiry was made at the end of the examination; any questions needed for clarification were asked during the examination proper.

C. FINDINGS

1. *By Variables*

Age changes in all variables are given in Table 4. Details of change by separate variables follow.

a. Area. For every group and on both tests, except for the Masonic group on Test 2, D% predominates over W%. For every group, W% increases with age and D% decreases slightly. Dd% falls off rather sharply except with the Victoria subjects. Means are given in Table 4. In the majority of individual subjects, W% increases with age. Direction of area changes in individual subjects is given in Table 5.

b. Number and refusals. The trends here are clearcut. For each of the three groups of subjects as well as for the total population, mean N is lower for the second test than for the first. Means as well as changes in individual records are given in Table 6.

The smallest decline in mean N is thus for the Victoria group, next for the Masonic group, greatest for the New Haven subjects. Over two thirds of all subjects give fewer responses on Test 2. Of the 24 per cent, or 15 subjects, who give more responses on the second test, 60 per cent achieve this greater number through an increase in Dd.

As to refusals, the trend is also clear. For every group except the Victoria subjects (where the differences are negligible, there being virtually no refusals on either test), there are more refusals on the second than on the first test.

Since refusals are so few, as Table 7 shows, even at the rather advanced ages represented by our subjects, the largest number of subjects for every group have an equal number of refusals (that is, none) on first and second tests. Of those in whom there is a difference, slightly more individual subjects give more than give fewer refusals on the second test. Rather large increase in mean number of refusals in the second group comes more from a large increase in a few subjects, than from a small increase in many.

The increased refusal along with narrowing down of N is one of the

TABLE 4

MEAN SCORES FOR MAJOR VARIABLES FOR ALL GROUPS

		Victoria		Masonic		New Haven		All	
		Mean	SD	Mean	SD	Mean	SD	Mean	SD
N	1st test	26.31	(12.58)	17.50	(8.47)	27.22	(14.06)	21.24	(11.54)
	2nd test	24.31	(10.42)	13.89	(8.07)	18.88	(8.87)	17.36	(10.30)
Refusals	1st test	.06	(.22)	.56	(.86)	.22	(.62)	.38	(.75)
	2nd test	0	0	1.17	(1.98)	.33	(.67)	.74	(1.62)
W%	1st test	31.81	(19.11)	40.94	(25.12)	34.78	(19.86)	37.64	(23.30)
	2nd test	34.13	(17.44)	49.25	(25.45)	45.55	(23.34)	44.59	(24.42)
D%	1st test	52.06	(12.96)	48.11	(19.57)	49.00	(12.37)	49.28	(17.80)
	2nd test	51.25	(15.66)	41.78	(19.39)	48.44	(16.33)	45.25	(18.52)
Dd%	1st test	13.63	(15.67)	11.17	(13.55)	15.67	(12.45)	12.48	(14.15)
	2nd test	13.69	(15.31)	8.83	(13.55)	5.89	(9.29)	9.67	(13.76)
F%	1st test	57.56	(14.83)	65.14	(20.15)	65.78	(16.96)	63.25	(18.71)
	2nd test	61.25	(19.15)	67.81	(19.38)	63.22	(21.94)	65.41	(19.96)
F+%	1st test	82.94	(12.06)	75.80	(21.54)	89.44	(8.60)	79.69	(18.65)
	2nd test	75.50	(20.08)	75.36	(20.59)	85.11	(11.09)	76.84	(19.62)
M	1st test	2.44	(1.21)	1.72	(1.89)	2.00	(2.40)	1.95	(1.88)
	2nd test	3.44	(3.55)	1.64	(1.55)	1.56	(1.43)	2.10	(2.39)
FM	1st test	3.31	(1.11)	1.31	(1.41)	2.78	(1.13)	2.05	(1.58)
	2nd test	2.38	(1.83)	1.50	(1.98)	3.56	(3.41)	2.03	(2.33)
m	1st test	.38	(.60)	.31	(.61)	.89	(.95)	.41	(.71)
	2nd test	.50	(.61)	.47	(.82)	.89	(.87)	.49	(.81)
sC	1st test	2.13	(2.17)	.97	(1.11)	1.39	(1.50)	1.34	(1.06)
	2nd test	1.38	(1.53)	.36	(.68)	.22	(.35)	.61	(1.06)
F(C)	1st test	2.12	(2.50)	.89	(1.09)	1.67	(1.33)	1.33	(1.66)
	2nd test	1.38	(1.47)	.64	(1.44)	.67	(1.33)	.84	(1.46)
No. content categories	1st test	6.06	(1.76)	3.94	(1.41)	5.78	(2.61)	4.77	(1.99)
	2nd test	5.50	(2.88)	3.42	(1.51)	4.55	(1.77)	4.33	(2.19)
H%	1st test	17.56	(7.91)	18.33	(16.31)	13.44	(11.88)	17.41	(14.04)
	2nd test	17.63	(14.65)	23.23	(20.91)	15.78	(12.21)	20.72	(18.56)
A%	1st test	50.56	(12.92)	52.86	(23.84)	47.33	(14.02)	51.44	(18.17)
	2nd test	54.63	(22.45)	55.86	(21.20)	54.67	(14.78)	55.36	(21.10)
No. anat. responses	1st test	2.13	(5.01)	3.33	(8.32)	2.22	(2.61)	2.85	(6.60)
	2nd test	.56	(.87)	1.00	(2.28)	.78	(1.58)	.85	(1.92)

TABLE 5

DIRECTION OF CHANGE IN AREA IN INDIVIDUAL SUBJECTS

No. of subjects for whom W% on second test	Victoria	Masonic	New Haven	All
Decreases	9	15	3	27 (44%)
Equals first	0	0	0	0
Increases	7	21	6	34 (56%)

TABLE 6
MEAN AND INDIVIDUAL CHANGES IN NUMBER

Mean N	Victoria	Masonic	New Haven	All
First test	26.25	17.50	27.22	21.24
Second test	24.31	13.89	18.88	17.36
No. of subjects for whom second N				
Decreases	8	27	7	42(69%)
Is equal	2	0	2	4(7%)
Increases	6	9	0	15(24%)

TABLE 7
MEAN AND INDIVIDUAL CHANGES IN NUMBER OF REFUSALS

	Victoria	Masonic	New Haven	All
Mean no. of refusals				
First test	.06	.56	.22	.38
Second test	.00	1.16	.33	.74
No. of subjects whose refusals on second test are				
Fewer	1	6	2	9(14%)
Equal	15	20	7	42(69%)
More	0	10	0	10(16%)

most common devices by means of which the older subject attempts to give a creditable response, and, in his own eyes, to avoid "failure."

c. Form and correct form. The trend for F% is extremely variable. Means for Victoria and for New Haven subjects, probably the more intelligent and more intact, show a slight but clear decrease in F%. Mean F% for Masonic subjects increases on the second test. For the total group, means for first and second tests are almost identical.

Table 8 gives means for both tests, and number of subjects who follow group trends. As appears, just over half of all subjects have an increased F% on a second test. However, perhaps surprisingly, 43 per cent have a decreased F%. This decrease in F%, which occurs rather contrary to what might be expected, results chiefly from an increase of M. Of the 26 subjects in whom F% decreases, 16 have an increase—often a sharp increase—in M; five have an increase in FM. In one or two further instances, the enlivenment actually remains the same, i.e., same number of movement responses, but a reduced N results in a lower F%.

For every group of subjects, F+% falls off at least slightly in the second test. Means for the two tests, and the number of subjects in each group for whom F+% is greater or less appear in Table 8.

TABLE 8

MEAN AND INDIVIDUAL CHANGES IN F% AND IN F+%

	Victoria	Masonic	New Haven	All
Mean F%				
First test	57.56%	65.13%	65.77%	63.24%
Second test	55.00%	67.77%	63.22%	63.78%
Mean F+%				
First test	82.50%	75.50%	89.04%	79.68%
Second test	75.50%	75.36%	87.03%	76.01%
No. of subjects for whom second F% is				
Less	7	14	5	26(43%)
Equal	1	2	0	3(5%)
Greater	8	20	4	32(52%)
No. of subjects for whom second F+% is				
Less	7	14	5	26(42%)
Equal	1	2	0	3(5%)
Greater	8	20	4	32(52%)

Thus though means for each group do show a decreased F+% on the second test, it will be seen that just over half of all subjects show an increased F+%. Since it seems unlikely (though possible) that subjects are becoming increasingly accurate of perception as they grow older, it will be of interest to note by what devices those subjects who do produce a higher F+% on a second test, accomplish this. Among the most common devices for the maintaining or increasing of F+% are the following:

1. *Increased number of refusals.* As will be seen under the section on refusals, the mean number of refusals for the second test has doubled over that on the first. Thus the older subjects refuse many of the more difficult cards and thus, responding only to cards which are easy for them, become apparently more accurate.

2. *Lowered N.* Even in subjects who give no refusals, mean N is lower for the second test. This may mean that subjects on the second test tend to give a response which is easy or obvious for them, but do not make the added and potentially unsuccessful effort to give additional responses.

3. *F-Movement responses.* There is a tendency, though a variable one, for there to be more movement responses on the second than on the first test. Often these movement responses are poor form responses, but since they are scored M rather than F, the poor form is lost in the scoring.

4. *Increased A%.* All groups increase in A% on the second test. Since A responses are often popular, or at least are often of easy and obvious form, such responses tend to be accurate and to elevate the F+%.

In thus observing the many ways in which the aging person manages to maintain or even to increase his F+% as he grows older, we have one of our clearest glimpses of the aging mind at work, and of the devices which the individual uses, often unconsciously, in his effort to continue a good acceptable adaptive response to the demands of the environment. An example of a successful effort—but at what a cost—to maintain a good F+% may be seen in the second record of Mrs. B. (Tables *A-B*).

d. Movement, color, shading and *experience balance.*

(1). *Human movement.* The fact that individual subjects with aging

TABLE *A*

Mrs. S. B., 82 years: Test 1

W F— anat.	I.	(Looks on back.) Why I don't know. If it's a picture they took of me? (No.) I thought not. Couldn't see any resemblance. (What *do* you see?) I don't know. It looks as if it might be the insides of somebody.
W F+ A	II.	Well that looks to me like a bat. (Just the black.) (Else?) No.
W F— anat. W F— elim.	III.	Another one? Well it looks like some parts of a body but I couldn't tell you just what. Just the separate parts. You know, you had your bowels move or something like that—the flow out.
W F— anat. Do F+ Hd	IV.	Oh oh oh oh! Well I suppose that's some parts of the body. And that looks like the feet.
W F— anat.	V.	Another one? Well it looks like some parts of the body. I couldn't tell you what. I don't know. These (lower projections) look like the lower part of the body. (Looks on back.)
W F— anat.	VI.	(Sighs.) Another one yet! You got me there. I suppose it's some part of your body but couldn't tell you what it looked like.
W F— anat.	VII.	Whew! Well it looks like that *might* be the back (bottom). And then the other parts that come up from it but can't tell you what the parts are. (Smiles in a friendly way.) How do they make these? (Ex. explains.) Taken from X-rays?
W F— anat.	VIII.	Now that looks like the back (bottom) and those come up around there.
W F— anat.	IX.	Well you've got me there! I can't tell. (Looks on back.) Could it be picture of the front of anybody? (Could.) Well I thought so.
D F± A D F+ A D F+ A	X.	(Long careful regard.) Well I give that up I guess. It looks like two turtles on each side. (blue). And then this (top gray), two animals of some kind. But what are these? That looks like a mouse (side). But I can't figure on those (pink).

Best: X
Worst: IV
N = 14

10W = 71%W
3D = 21%D
1Do = 8%Dd

14F = 100%F
4F+, 1 F±, 9F— = 32%F+
OK: OsC

4A = 28%A
8 anat + 1 elim = 65%
1Hd = 7%H

TABLE *B*

Mrs. S. B., 86 years: Test 2

—	I.	(Looks on back.) Yes. (Front). Well, I couldn't tell what it is. It looks like the back, the front. But what it is, I can't tell you.
W FM A	II.	Something holding up. I don't know what they're holding up. It's something they're holding up. Two arms up there. But the under part I can't tell you what that is. But they've got their two paws up there anyway.
—	III.	You got me there. I don't know what that is. It doesn't look like anything I could tell you about. I don't know what that is.
D F±Ad	IV.	That looks like the front of something. (Midline). Outside of that I couldn't say. (?) Some animal?
D F— AD	V.	That there looks like the front of somebody or something. (She fingers midline). I don't know what the sides look like. It doesn't look like the finishing of a person.
Denies Hd	VI.	∧> I don't know what that looks like. Doesn't look like a person, the lower part of anybody. You got me with that.
—	VII.	< V > You got me there.
Color remark	VIII.	I don't see it makes me think of anything. Color in there
Denies Hd		belongs to something. Not any part of a person.
D F+ A P		That there looks like an animal, and that there does. (Usual animals.)
—	IX.	< V > Well I don't see anything there it reminds me of.
D F+ A P	X.	That there and there looks like a little animal of some kind. But outside of that I don't see anything. (Usual blue.)
N = 5 + 2 denials + 4 refusals		4F = 80%F 2F+, 1 F±, 1 F— = 62%F+ 1FM 2A, 2 Ad = 100%A
1W = 20%W 4D = 80%D		OM: OsC

respond so individually with regard to M, results in mean Ms which for first and second tests are almost identical. That is, of subjects whose M does not remain the same for the first and second tests, almost equal numbers give more and fewer M. The significance of increased M in the aging subject will be discussed later. Mean figures for all subjects for first and second tests, and number of individual subjects who change in either direction, are given in Table 9.

Thus it appears that means for New Haven and Masonic groups decrease slightly; for Victoria subjects, increase; for the total group remain almost identical. Nearly equal numbers of individual cases increase and decrease.

(2). *Animal movement.* With respect to this particular score, trends in our several groups of subjects are also extremely variable. Mean FM for Victoria subjects is conspicuously less for the second test. For Masonic subjects, it remains steady. For New Haven subjects it increases. For

TABLE 9
MEAN AND INDIVIDUAL CHANGES IN NUMBER OF M

	Victoria	Masonic	New Haven	All
Mean M				
First test	2.43	1.72	2.00	1.95
Second test	3.43	1.63	1.55	2.09
No. subjects whose second M is				
Less	4	15	4	23(38%)
Equal	3	11	2	16(26%)
Greater	9	10	3	22(36%)

individual subjects, the tendency is to give a slightly lower FM on the second than on the first test.

(3). *m.* As Table 4 indicates, m occurs very little in this age range, though there is a very slight tendency for it to increase with age. Most m is found in the New Haven subjects. As to individual subjects, 30, or nearly 50 per cent have no m on either test. Of the others, 13 have more on the second test, 13 have fewer, 5 are tied. There are no conspicuous group differences.

TABLE 10
MEAN AND INDIVIDUAL CHANGES IN NUMBER OF FM

	Victoria	Masonic	New Haven	All
Mean FM				
First test	3.31	1.30	2.27	2.05
Second test	2.37	1.50	3.55	2.06
No. subjects whose FM on second test is				
Less	8	12	4	24(39%)
Equal	5	13	2	20(33%)
Greater	3	11	3	17(26%)

(4). *Interpersonal M.* For all three groups of subjects, the mean number of interpersonal M, and also the mean precentage of all M expressing interpersonal relations, have been computed. For each of the three groups, as Table 11 shows, the mean number of interpersonal M increases

TABLE 11
MEAN NUMBER, AND MEAN % OF ALL M WHICH ARE INTERPERSONAL

	Test 1		*Test 2*	
	Mean Number	Mean %	Mean Number	Mean %
New Haven	1.00	24.77%	1.33	69.88%
Victoria	.93	36.87%	1.68	47.12%
Masonic	.88	26.86%	.94	32.86%

from Test 1 to Test 2. Also the mean per cent of all M responses which involve interpersonal relationships increases for each of the three groups, with age. Differences between Tests 1 and 2 are statistically reliable at the .05 level[2] for the New Haven group. In other groups, not enough subjects give M on both tests to show a significant difference between the two tests.

As to individual subjects, in the New Haven group, 44 per cent of subjects (four individuals) give more interpersonal M responses on Test 2 than on Test 1. Two others have an equal number on both tests, and the remaining three give no movement responses, 56 per cent of Victoria subjects give more interpersonal M on Test 2 than on Test 1. Only 22 per cent of Masonic subjects have more interpersonal M on Test 2, but 41 per cent have no M on either.

(5). *Color.* Table 12 gives mean and individual age changes in FC, CF, C, and sC. For all but the New Haven subjects, mean FC, though small in every instance, is slightly smaller on the second test than on the first. In only four subjects is FC larger on the second test. In 15 subjects, FC is smaller on the second test. In 42 cases it is equal on both, usually zero.

CF responses are somewhat more frequent than are FC. For the group

TABLE 12
Mean and Individual Changes with Age in Color Response

	Victoria	Masonic	New Haven	All
Mean FC				
First test	.41	.36	.12	.37
Second test	.12	.08	.13	.11
Mean CF				
First test	.94	.61	.44	.67
Second test	1.20	.33	.11	.52
Mean C				
First test	.25	.11	.33	.18
Second test	.12	.00	.00	.03
Mean sC				
First test	2.12	.97	1.38	1.33
Second test	1.37	.36	.22	.61
No. of subjects whose sC on second test is				
Less	10	19	5	34(56%)
Equal	1	1	1	3(5%)
Greater	4	4	0	8(13%)
No color on either test	1	12	3	16(26%)

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[2] Sign test, Dixon and Massey, 7, p. 247.

as a whole, and for all sub-groups except the Victoria subjects, there are slightly fewer CF on the second than on the first test. As to individual subjects, 10 have more CF on the second than on the first test, 21 have fewer, 30 have the same number and this number is predominantly zero.

Very little C is used by any subjects, but means for all groups are smaller for the second test than for the first. Of the total group only one subject uses more C on the second than on the first test, 8 use fewer and 53 are equal—usually with no pure C.

Mean sC decreases for every group of subjects from the first test to the second and in every group the majority of subjects give fewer color responses on the second test. The greater tendency for color to diminish than for movement will be discussed elsewhere.

(6). *Shading.* Shading responses are relatively few, but for every group of subjects there is a slight decline in mean number. Only eight subjects give more shading on Test 2 than on Test 1; 31 give less, and 22 give the same number, though 20 of these give no shading on either test. Means are given in Table 13.

TABLE 13

MEAN AGE CHANGES IN NUMBER OF SHADING RESPONSES

	Victoria	Masonic	New Haven	All
Mean no. of F(C)				
First test	2.0	.89	1.7	1.3
Second test	1.4	.64	.67	.84

(7). *Experience balance.* Mean experience balance for every group of subjects on both first and second tests is introversive, as Table 14 shows. Also as far as individual subjects are concerned, the largest number in every group and for both tests are introversive.

Of the 12 subjects who change from extratensivity to introversivity or vice versa, between the first and the second test, 10 change from extratensive to introversive, only two from introversive to extratensive. Other subjects become more introversive (a frequent occurrence), remain ambiequal—usually OM:OsC—(also a frequent occurrence), become increasingly extratensive (not common), or simply lose all enlivenment on the second test. Or in rare instances change from ambiequal to either introversive or extratensive.

e. Content.

(1). *Number of content categories.* For each of the three groups of subjects there is at least a slight decline in the number of content categories

TABLE 14
MEAN AND INDIVIDUAL CHANGES IN EXPERIENCE BALANCE

	Victoria	Masonic	New Haven	All
First test	2.43M:2.12sC	1.72M:.97sC	2.00M:1.38sC	1.95M:1.33sC
Second test	3.43M:1.37sC	1.63M:.36sC	1.55M: .22sC	2.09M: .61sC
No. of subjects on each test who are		*Introversive*	*Ambiequal*	*Extratensive*
Victoria	First test	10	0	6
	Second test	8	4	4
Masonic	First test	17	10	9
	Second test	23	11	2
New Haven	First test	5	1	3
	Second test	7	2	0
All	First test	32	11	18
	Second test	38	17	6

TABLE 15
MEAN AND INDIVIDUAL CHANGES IN NO. OF CONTENT CATEGORIES

	Victoria	Masonic	New Haven	All
Mean no. categories				
First test	6.06	3.91	5.77	4.75
Second test	5.50	3.42	4.55	4.13
No. of subjects whose no. of content categories on second test is				
Less	8	20	6	34(56%)
Equal	4	7	2	13(21%)
Greater	4	9	1	14(23%)

used. At least 50 per cent of each group also give fewer content categories on the second than on the first test.

(2). *Constancy of content.* Earlier investigation of the extent to which content of responses remains constant in any one subject from year to year (2) has shown that in some subjects a fairly high degree of constancy does maintain. Thus in a group of young subjects between the ages of 2 and 10 years, consistent responses (the same content on any one card on four or more consecutive yearly tests) were found on a mean of 3.9 cards per subject. At older ages (10 to 16 years) means for constant responses per subject were 4.8 for girls, 5.0 for boys.

In present subjects, constancy of content is found, as Table 16 shows, to be considerable, even after a lapse of four years. The range of mean number of responses remaining constant is, for different groups of subjects, from 3 to 4, there being from 0 to 11 such responses per subject. With

TABLE 16

	Mean no. of constant responses	Range	Number showing	—	Percent constancy	Mean No. of cards showing constancy
New Haven	4.22	2-7	9	—	100%	4.22
Victoria	3.75	0-9	14	—	87%	3.56
Masonic	3.38	0-11	35	—	97%	3.25

only a few exceptions, there is not more than one such response to any one card. Thus the response to three or four cards remains constant for most subjects. All of the New Haven subjects, 87 per cent of the Victoria subjects, and 97 per cent of the Masonic group have at least one identical response from age to age.

(3). *A%, H%, and anatomy %.* For A% as with several other scoring variables, the trend with age is clearcut and uniform from group to group. For all three groups of subjects, mean A% is higher for the second than for the first test. There is considerable variability as to individual subjects, but for each group of subjects more than 50 per cent give a higher A% on the second test.

As to H%, for two of the three groups (Masonic and New Haven), H% increases on the second test. For Victoria subjects it remains the same. There exists marked differences as to whether individual subjects increase or decrease in H% on a second test, though fewer increase than decrease except in the Victoria group.

The trend for anatomy responses in every group is toward fewer responses and a lower anatomy per cent on the second test. Only 11 of the 61 subjects have more anatomy on the second than on the first test. Twenty-two have less. The remaining 28 have an equal number on the two tests, though a majority of these give no anatomy on either test, so the correspondence is not striking.

2. *Sex Differences*

Since there is a markedly disproportionate number of women among our subjects (49 women, 12 men), and the contributing groups come from rather varied backgrounds, sex differences were measured only for the largest homogeneous group (Masonic subjects: 29 women, 7 men) rather than for the total population.

Sex differences on Test 1, as reported in our earlier study (4) were that men were considerably more restricted than women, giving many fewer

TABLE 17
MEAN AND INDIVIDUAL AGE CHANGES IN A%, H%, AND ANATOMY %

	Victoria	Masonic	New Haven	All
Mean A%				
First test	50.56%	52.86%	47.55%	51.49%
Second test	54.62%	55.86%	54.66%	55.37%
Mean H%				
First test	17.56%	18.33%	13.44%	17.45%
Second test	17.62%	23.33%	15.77%	20.73%
Mean Anat%				
First test	10.8%	13.3%	13.1%	12.6%
Second test	1.8%	6.5%	5.2%	5.1%
No. Subjects whose A% on second test is				
Less	7	16	3	26(43%)
Equal	0	0	0	0
Greater	9	20	6	35(57%)
No. Subjects whose H% on second test is				
Less	9	15	3	27(44%)
Equal	1	2	0	3(5%)
Greater	6	19	6	31(50%)

N, more refusals, a much higher W%, fewer M, fewer content categories, and a higher A% (although a slightly lower F%).

A comparison of sex differences on Test 2 and of the changes between the two tests shows slightly paradoxical behavior. In certain respects, although the men continue to appear more restricted than the women, and both sexes seem more restricted on the second test—with still fewer N, more refusals, higher W% and fewer content categories—the women as compared to the men have a higher A%, higher F%, and fewer M on the second test. The men seem in some respects to stabilize, giving considerably more M (a mean increase of 1.5M over the initial record), lower F%, and a lower A%. Even the number of responses declines proportionately less in the men (Table 17A).

3. *Change of Category*

In our earlier study of Rorschach responses in old age, we have classified responses as normal, presenile, or senile. For most of the 61 subjects of the present study, the interval between the first and second tests was between four and five years. Of these subjects, 24 did not change status during this interval. That is, they were on second as on first test, either in the normal, presenile, or senile category as follows: three subjects, two of them of the

TABLE 17A
SEX DIFFERENCES

N:	Considerably fewer N on the first and second test for the men. Men decline less rapidly than do women in total N, though they remain considerably more restricted in output.
Refusals:	Although the general trend with both is the same, that is more refusals on the second test, men refuse considerably more (about .75 cards per subject) than do women on both tests.
F%:	is slightly less initially in women than in men; however where women tend to increase somewhat in F% on the second test, men decline by 8%.
F+%:	Extremely similar course in both men and women. Men's F+% is consistently 4% less than that of women.
M:	Whereas on the initial test men give an average of almost 1 fewer M per subject, on the second test women decline in number of M, while men increase by 1½ per subject.
FM:	FM reverses the M pattern, with women giving more FM on both tests, and increasing their output on the second test, whereas men decline.
M:	Men the same on both tests as the women.
sC:	Almost identical course. sC drops out with both.
H%:	In both sexes, H% increases from the first to the second test; however it is not only higher in men initially, but increases (by 13%) more sharply in the men.
A%:	Starts higher in men, but whereas with women it rises somewhat, with men it declines sharply (by 10%).
Content categories:	Men consistently have fewer than do women.
Anatomy:	Considerably less in men on both tests than in women.
F(C):	Less for men on both test than for women.
W%:	Remains considerably higher (by 20%) on both tests in men than in women.

Masonic and one of the New Haven group were for both tests in the normal category; 20 subjects, eight in the Victoria group, 10 in the Masonic group, two in the New Haven group, were in the presenile category for both tests; one, a Masonic subject, was in the senile category on both.

Five subjects—three of the Masonic and two of the New Haven group—do appear to improve with age. Of these, three merely improved within the presenile category, changing to more intact presenility. Two others improved from senile to deteriorated presenile.

Thirty-two others, the largest number, give a less intact response on the second than on the first test. Of these, 13 deteriorated from normal to presenile; 13 others from relatively intact presenile to more deteriorated

TABLE 18
CHANGES IN INCIDENCE OF LEADING A- AND B- LIST ITEMS FROM TESTS I TO II*

		New Haven			Victoria			Masonic		
		Test 1	Test 2	+ or — on 2	Test 1	Test 2	+ or — on 2	Test 1	Test 2	+ or — on 2
	A-list items									
A1.	Thinks own concept right or wrong	3	3	+	6	1	—	20	11	—
A2.	F% over 50%	8	7	—	10	8	—	30	27	—
A3.	A% over 50%	4	5	+	10	8	—	20	21	+
A7.	Low F+ (80% or less)	1	2	+	5	6	+	13	15	+
A8.	Tells own experiences	6	6	=	5	6	+	13	6	—
A9.	Gives qualifying remarks	6	3	—	5	4	—	12	12	=
A12.	FM = or > M	6	6	=	0	0	=	6	0	—
A16.	"Could be", "might be"	5	7	+	10	6	—	20	10	—
A17.	Initial exclamations	4	5	+	7	8	+	21	19	—
A20.	Low R — 15 or fewer	1	4	+	3	3	=	18	25	+
A21.	Narrow content (4 or less)	2	3	+	2	6	+	22	30	+
A32.	Says "too hard" or "don't know" and then responds adequately	4	2	—	8	5	—	19	21	+
	B-list items									
B1.	One or more anatomy	8	2	—	3	7	+	15	11	—
B5.	H% 15% or more	2	4	+	6	9	+	19	20	+
B7.	Complains of being stupid or dumb	4	5	+	7	1	—	10	6	—
B9.	OsC	3	6	+	2	7	+	14	26	+
B16.	Questions card, addressing it directly	2	1	—	0	1	+	2	0	—
B19.	Discusses response with self	4	4	=	9	1	—	7	6	—
B20.	Asks Ex. what answer is	0	1	+	5	8	+	18	10	—
B30.	Use of "somebody", "something"	1	1	=	8	1	—	11	11	=
B36.	Perseveration of remarks	2	3	+	6	3	—	18	8	—

* Items which occur mean .4 or more on either test for any group are included in this summary.

presenile; five from presenile to senile; and one from relatively intact senile to more deteriorated senile.

Thus, in summary, 39 per cent of subjects remain in the same category on the two tests; 8 per cent improve; 52 per cent grow worse.

a. Sex differences. Of the subjects who improve, four are female and one is male. Of those whose protocols remain in the same category, 20 are women, four are men. Of those who deteriorate, 25 are women, seven are men. Thus relatively more men than women deteriorate from their original category to one which is less intact.

4. *A- and B-List Signs of Presenility*

In our earlier study of Rorschach responses in old age (4) we identified 57 items or ways of responding which especially characterize the responses of elderly subjects. These have been divided into two groups—A-list items and B-list items. A-list items are those ways of responding found earlier, in childhood, which largely disappear in maturity but which reappear in old age. B-list items are those which appear first in old age or which at least have never been given conspicuously at earlier ages. Items from both lists given here in Table 18 show the nature of these signs. For a complete listing of all A- and B-list signs, see Rorschach Responses in Old Age (4). Table 18 shows specifically which items occur predominantly in present subjects. All items were listed which occurred on either test for any group to the extent of mean .4. Except for the Victoria group, more A-list items increase with age than B-list items.

TABLE 19
A- and B-LIST ITEMS

	Means					
	Test I			*Test II*		
	A-list	B-list	Both	A-list	B-list	Both
New Haven	6.66	6.45	13.11	7.33	6.00	13.33
Victoria	5.75	7.31	13.06	4.62	6.25	10.87
Masonic	7.75	6.69	14.44	6.58	5.08	11.66

		A or B leads in Individual Subjects	
		Test I	*Test II*
New Haven	(9)	A leads in 5 B leads in 3 = in 1	A leads in 6 B leads in 2 = in 1
Victoria	(16)	A leads in 6 B leads in 10	A leads in 3 B leads in 12 = in 1
Masonic	(36)	A leads in 20 B leads in 9 = in 7	A leads in 23 B leads in 9 = in 4

Table 19 gives means for both A- and B-list items for all three groups of subjects, for first and second tests compared. As far as the means are concerned, differences are very small, but for both tests A-list signs lead slightly with New Haven and Masonic subjects, B-list items for Victoria subjects. Similarly, counting individual subjects, the majority except in the Victoria group have more A- than B-list signs.

As Table 19 shows, only in Victoria subjects does mean number of B-list signs exceed mean number of A-list signs; and only in Victoria subjects do more individuals give a predominance of B-list over A-list signs. A- and B-list signs both tend to fall off slightly on Test 2 as compared with Test 1.

D. DIFFERENT KINDS OF RESPONSE AND DIFFERENT GROUPS COMPARED

1. *Two Different Kinds of Response*

A large proportion of elderly subjects become increasingly restricted in response as they grow older. The common trend is toward a decrease in N, a decrease in variety of content categories, and a decrease and eventual dropping out of color responses with increasing age. Many also show a higher F%, a lower F+%, lower M and FM, and a higher A%. All of these changes add up to an extremely static, stereotyped, and restricted picture of the psyche of the aging individual.

However, there appear to be some elderly subjects who though inevitably showing some of the restriction common to old age do tend to stabilize in their Rorschach response and then to develop in a manner specially characteristic of well-preserved old age. That is, instead of increasing, F% decreases; F+% increases; and both human response and human movement —especially interpersonal movement—come in strongly. Or the response may expand in the direction of abstract or idealized responses.

Subjects of the present study were classified on the basis of these two categories. They were classified as "stabilized" on the second test in those cases where F% decreased, F+% increased, M and thus H% increased, and A% decreased. They were classified as "more restricted" when F% was higher, F+% was lower, M was lower, A% was higher, and usually N was lower. Otherwise they are classed as "mixed."

Table 20 shows that except for the Victoria subjects, who appear to be extremely well-preserved as a group, the largest number in each of the other groups do become more restricted on a second test. But that in every group, a substantial number of subjects do move in a direction other than

TABLE 20
SECOND RESPONSE AS COMPARED WITH THE FIRST

	Stabilized	More restricted	Mixed
New Haven	22%	44%	33%
Victoria	37%	25%	37%
Masonic	22%	44%	33%

the expected restriction—that is, they are less restricted and thus more enlivened, and more accurate, on a second test than on a first even though several years older at the time of the second test.

Sample scores for stabilized and more restricted responses on a first and second test are given in Table 21.

TABLE 21
EXAMPLES OF DIFFERENT TYPES OF CHANGE ON SECOND TEST

Stabilized on second test		
Miss J. M.: *81 years:* N = 39 5W = 13%W 16D = 41%D 17Dd, 1Dbl = 46%Dd	28F = 72%F 9F+, 15F±, 4F— = 59%F+ 4M, 4FM, 1 CF, 2 F(C) 4M: 1sC	7A, 8Ad = 38%A 4H, 4 Hd, 2 (H) = 26%H 2 anatomy = 5% 2 obj; 3 map; 3 nat; 1 plant; 1 flower; 1 geol; 1 arch.
85 years: N = 43 3W = 6%W 16D = 37%D 24Dd = 58%Dd	27F = 62%F 17F+, 10F— = 81%F+ 12M, 2FM, 1 m, 1 F(C) 12M: OsC	8A, 2Ad, = 23%A 10H, 14 Hd = 55%H 5 objects; 1 food; 1 plant; 1 scene; 1 anatomy = 2%
Restricted on second test		
Mrs. A. E.: *82 years:* N = 10 (+ 1 refusal) 7W = 70%W 3D = 30%D	7F = 70%F 6F+, 1 F± = 93%F+ 2M, 1 FC 2M: ½sC	3A, 1 Ad = 40%A 2H = 20%H 1 anatomy = 10% 3 objects
86 years: N = 9 (+1 refusal) 4W, 1 WS= 55%W 4D = 44%D	9F = 100%F 3F+, 2F±, 4F— = 44%F+ OM: OsC	6A, 2 Ad = 88%A 1 object.

2. *Further Comparison of the Two Different Institution Populations*

As Table 3, which gives comparative data on occupational levels of subjects in our three separate groups shows, there is a clear difference between the two institutional populations. The largest single group of Victoria subjects falls in Class I; the largest single group of Masonic subjects is in Class V. Table 2, which gives comparative data on educational level, also shows a superiority in Victoria subjects in that 75 per cent of the Victoria group either graduated from high school or attended college, as compared with 46 per cent of the Masonic group. Our subjective evaluation of the two groups also places the Victoria subjects considerably higher so far as intelligence and social status are concerned.

So far as Rorschach performance goes, these two groups can be compared on the basis of the extent to which many variables occur; on the basis of the number of interpersonal M; on the incidence of A- and B-list items; and with regard to the extent to which the response to Test 2 is more restricted or more stabilized than that on Test 1.

a. Determinants. Referral to Table 4 shows that subjects in the Victoria group surpass the Masonic group in F+% on Test 1, and in number of responses, M, FM, sC and variety of content on both tests. Similarly, the Victoria group shows itself superior in response by lower F, lower A%, lower number of anatomy responses and fewer refusals on both tests. Victoria subjects also have a lower W% on both tests. The only respect in which the Masonic group possibly shows superiority is in its high H% on both tests. (And actually the meaning of high H% in these older subjects is not entirely clear.) Thus, measured in terms of determinants, Rorschach responses of the Victoria group are superior to those of the Masonic group.

Reference to Table 11 shows that the Victoria group gives a larger *percentage of interpersonal M* than does the Masonic group on both tests. Comparative percentages on Test 1 are 37 per cent for Victoria subjects, only 27 per cent for Masonic subjects; on Test 2, 47 per cent for Victorias, 33 per cent for Masonics.

So far as A- and B-list items are concerned, reference to Table 19 shows that on both tests, the Victoria subjects give more B-list than A-list responses; Masonic subjects give more A-list than B-list, both as to means and as to number of individual subjects. Our hypothesis is (1) that better endowed or better preserved subjects give more B-list than A-list items. Victoria subjects clearly predominate here in use of B-list items.

Greater restriction or greater stabilization on second test. The final comparison is that mentioned above (p. 276), between subjects whose response on the second test is more restricted than on the first, and those whose response on the second test seems to stabilize, with lower F%, higher F+%, and higher M. Such a comparison shows that more (37 per cent) of Victoria subjects become stabilized on Test 2 as compared with only 22 per cent of Masonic subjects; while only 25 per cent of Victoria subjects but 44 per cent of Masonics are more restricted on Test 2.

Thus by every measure, Victoria subjects seem to be better endowed and better preserved. The group whose educational and occupational level is highest does in this instance give the better Rorschach performance. However, it must be taken into account that Victoria subjects as a group are slightly younger than the Masonic subjects. Fifty-three per cent of Masonic subjects, but 63 per cent of Victorias are still in their seventies; 33 per cent of Masonics and 31 per cent of Victorias are in their eighties; 14 per cent of Masonics but only 6 per cent of Victorias are in their nineties. Thus the difference in performance between the two groups may be partly a function of age.

E. Discussion

From these findings as to the direction of change in the Rorschach response of individual old persons, as well as of groups, as old age advances, a reasonably clear picture of the aging psyche emerges. Rorschach himself (19) has listed three signs "pathognomic" of old age: "(*a*) A coarcted Erlebnistypus, that is, a diminution of the capacity of old people to make use of their inner resources and a weakening of their reaction to emotional challenges. (*b*) Vaguely or inaccurately seen forms, indicating a lessening of perceptual acuity and a somewhat lowered level of intellectual efficiency. (*c*) A highly restricted thought content demonstrating a narrowing of the range of interests." Findings of subsequent investigators, summarized in detail in Ames *et al.* (4, p. 5-13), agree with these observations in most respects, and in some instances do not go too far beyond these initial observations.

The picture of the aging psyche suggested by Rorschach and confirmed by subsequent studies on old age including our own, is further confirmed by findings of the present study. This picture is strengthened by the fact that means for the present group of subjects are for most variables even farther away from the figures for intact or "normal" adults than means for the same group four years earlier.

Thus we see the aging person as becoming increasingly restricted in the sector of experience to which he responds—lower N and more refusals, higher F%, less varied content, a tendency toward a decrease in movement responses, a clearcut trend toward a decrease or disappearance of color and shading responses.

Accuracy of perception falls off, though the older person can sometimes maintain a reasonably high accuracy by refusing difficult cards or by giving only easy or banal responses. Thus accuracy may be maintained but at the expense of both quality and quantity of response.

Without exception, for each subgroup and for the group as a whole, the majority of subjects give a response which is introversive on both first and second tests. Color when given is mostly CF, but mean sC on the first test is only 1.33 and on the second has dropped to .61. In fact, 19 subjects on Test 1 and 40 on Test 2 give no color responses of any kind. This suggests that the aging individual becomes less responsive to the environment and more and more motivated by his own inner drives and impulses. It also suggests that the easy tears and laughter of the presenile person may be surface phenomena, not supported by strong emotional drives.

The mean for shading response equals the mean for all color responses on the first test, slightly exceeds it on the second. The implication of this can be drawn by comparing Rorschach's definition of F(C) responses as indicating a "timid, cautious and hampered sort of adaptability . . . and a tendency toward a fundamentally depressive disposition which the subject tries to control when others are present" (19) and with Piotrowski's exposition of the meaning of color responses, which is as follows:

> The perceptanalytic color responses denote emotions, i. e., desire to associate with, or dissociate from, other persons (1) with the intent of a voluntary or forcible continuance or discontinuance of exchange of pleasures and/or pains . . . and (2) accompanied by some conscious idea as to whether the emotional attitude of the subject toward the other person is fully or partially reciprocated. . . . The sum of weighted color responses, sC, indicates the degree of emotional responsiveness to the environment or the amount of emotional interest in the outside world (17, p. 224).

Though the majority of subjects on both tests are, as noted above, introversive, individual differences as to amount of M are great—38 per cent of all subjects having fewer M on Test 2 than on Test 1, 26 per cent having an equal number and 36 per cent fewer. Means are low—1.95 on Test 1; 2.10 on Test 2. Similarly, 39 per cent of subjects give fewer FM on the second test than on the first, 33 per cent give an equal number and 26 per cent give more, but the mean remains constant at 2.0. The excess of M over FM seen in normal adults does not occur here. There is a tendency for FM to exceed M (23 subjects on each test), or at least to equal it (19 subjects on Test 1, 10 on Test 2). Thus the aging individual has moved or is moving away from a kind of response in which M (standing for the most individual and integrated strivings which dominate life and stabilize the relation between the individual and his environment) predominate. Is moving toward a predominance of FM, or responses which indicate the ways in which an individual is likely to behave when he acts in a state of markedly lessened integration (17, p.190).

The substantial increase in A% may be correlated with a drop in intellectual level, with increase in psychogenic inhibition and with an unwillingness to exert oneself intellectually (17, p.341). Contrary to our earlier findings on a larger group (4), H% here increases with age, the means being 17.45 for the first test, 20.73 for the second. This suggests an increased interest in others, though Piotrowski suggests (17, p.347) that a H% over 20 per cent in a record of at least 30 responses, may suggest a fear of other persons and of their intentions.

The scoring trends just described hold for the majority of subjects. However, a substantial number of the apparently better endowed subjects, though showing some tendency toward increased restriction with older age, to some extent appear to give a stronger response than the less well-endowed, with often a lower F%, higher F+%, low A, high M and increasingly interpersonal M, or the giving of abstract or idealized responses. This lower F and higher F+, decreased A% and high M appear increasingly in a second later test on those well-endowed individuals whose response seems somewhat to stabilize with age.

At first glance such changes in the opposite direction from restriction might be interpreted as a return to a mature vigorous way of responding. However, we should keep in mind Piotrowski's interpretation that "an F% below 20 per cent suggests an insufficient attention to the immediate physical and social environment. Everything that happens around such subjects assumes a significant personal importance for them and clouds their judgment, for they are generally unable to maintain a detached, indifferent and objective attitude toward anything" (17, p.102). This low F combines with the high and increasing percentage of interpersonal M (as high as mean 70 per cent in one group on Test 2), to give a picture of such elderly subjects as almost completely concerned with their own interpersonal relations. Either friendly ("Gay old pair," "Having a grand time together"), or extremely unfriendly ("Oh I see real animosity in the faces of these two people"), these M suggest an extremely subjective interest in the individual's own activities and personal relations.

Even the abstract responses which occur in many, according to Piotrowski (17, p.213) describe unattainable though pleasant tendencies, repositories of the unconscious or indicators of repressed and unrealized action tendencies. In other words, quite the opposite of positive goals which the individual might be striving to realize.

F. SUMMARY

Sixty-one subjects over 70 years in age were given a second Rorschach test after an interval of, on the average, four to five years. The present study reports age changes in scoring, and in type of response which took place during this interval, as well as comparing responses in the three different groups of subjects—two institutional groups and one group of individuals still living independently in their own homes.

Subjects ranged in age from 70 to over 100. Individuals of all levels of social status and ability were included in our sample, but those of the higher levels were overly represented as compared with a total U.S. population.

Clearcut age trends were apparent for most major variables.

Number: Means for all groups decrease on the second test. And 69% of subjects have a smaller N, plus 7% who have the same number.

Correct form: F+% is slightly less for all groups on Test 2, though only 42% of subjects have a smaller F+%, plus 5% who remain the same on both tests. Decrease in correct form appears to be the most customary trend with increasing age. However, relatively intact individuals use various devices for maintaining a high F+. These include: refusing difficult cards, giving a lowered N—that is perhaps giving "easy" responses but not trying for difficult ones; hiding F— in increased movement responses; and by giving an increase of "easy" Animal responses.

Color: Here we found the most clearcut and consistent age changes. For every group, mean sC is lower on the second than on the first test. 26% of subjects gave no color response even on the first test. 56% more have less color on Test 2 than on Test 1. This leaves only 13% of all subjects in whom sC increases, plus 5% in whom sC is present but equal in both tests.

Shading: Every group gave a lower mean for shading responses on the second than on the first test; and the majority of individual subjects gave either no shading on either test, or if shading was present, less on the second test.

Content: For every group there was at least a slight decrease in number of content categories on Test 2, and 56% of individual subjects gave fewer different content categories on Test 2.

Mean A% was higher for every group on the second test, and 57% of all subjects had a higher A% on the second test. As to mean H%, except for the Victoria subjects whose H% was identical on the two tests, other groups gave a higher H% on the second test and 50% of individual subjects gave a higher H% on Test 2.

> A perhaps surprising number of responses (a mean of between 3 and 4 per subject) was found to remain constant—i. e., the same response was given—after the interval of from 4 to 5 years.

Slightly more variability was found for such variables as area, F%, and movement.

> *Area:* All groups gave a higher W% and a lower D% on the second than on the first test, and all but the Victoria group also gave a lower Dd% on the second test. D% predominated over W% in all groups on both test except for the Masonic group in whom W% predominated on Test 2.
>
> *F%:* In the population as a whole and in both institutional groups, F% increased with age. However in the New Haven group it was lower on the second than on the first test.
>
> *Human movement* increased on Test 2 in the Victoria group, fell off slightly, on the average in the other two groups. Animal movement fell off slightly in the Victoria group and increased slightly in the other two groups. Noteworthy among human responses was the increased number of inter-personal M which came in with increased age.

Test responses for both Tests 1 and 2 have been identified as "normal," "presenile," and "senile." Of our total population, 24 subjects did not change their status between Tests 1 and 2; 5 improved with age; 32 gave a somewhat less intact response on the second than on the first test.

The presence of certain kinds of response which have been identified as especially characteristic of presenility (A-list signs which are those ways of responding found earlier, in childhood, which largely disappear in maturity and then reappear in old age; and B-list signs which to a large extent appear for the first time conspicuously in old age) is noted, and age changes in these signs are described.

The most common trend in old age, as determined in an earlier study, was toward an increasing restriction of Rorschach responses as subjects grow older. The present longitudinal study, which follows individual subjects as they grow older, confirms that individual subjects as they age actually do proceed in the direction of change predicted from group averages. Thus the majority of present subjects, with increasing age, show decreased N, fewer content categories, fewer color responses. They show also an increased F% and a lower F+%, and a higher A%. All of this adds up to a picture of the psyche of the aging individual as being extremely static, stereotyped and restricted. (Though the better preserved, even while following this path, may not go far toward restriction.)

A few of the better endowed old people appear to stabilize their response, and show with increasing age a lower F%, higher F+%, and increased M, especially interpersonal M.

Comparison of the two different institution populations shows that the group rated higher in occupational and educational level gave a clearly "superior" Rorschach response when compared on the basis of actual scores, of the incidence of interpersonal M, on the incidence of A- and B-list items, and on the basis of stabilization or restriction of response with increased age.

As to sex differences—on Test 1 men's records were considerably more restricted than those of women in that men gave fewer N, more refusals, a higher W%, fewer M, fewer content categories and a higher A%, though higher F%. Differences remain about the same on the second test except that here men have a lower F% and more M than do women.

As the normal individual matures, ordinarily his emotional and intellectual responsiveness and potential become increasingly "mature," complex, and well-structured. As measured by the Rorschach, the number of responses given increases, fewer cards are refused, form becomes increasingly accurate, content more varied, responses to both emotional and environmentally structured drives fuller. Human movement responses come to exceed animal movement, color responses become more modulated, shading responses increase in number, there is less perseveration, and animal percentage decreases. This normal adult response continues to be given in many individuals well past the seventieth year of life.

But as the individual goes on into presenility and eventual senility, the direction of development appears to reverse itself. As the subject deteriorates, his response to the Rorschach becomes increasingly like that of a younger and younger person, and the changes described above are reversed.

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AGE CHANGES IN THE RORSCHACH RESPONSES OF INDIVIDUAL ELDERLY SUBJECTS*

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A. Introduction

Earlier studies (1, 2) have suggested that the Rorschach test can provide useful clues to the developmental status of the aging individual as well as to his unique individuality characteristics. Thus the Rorschach may indicate that some individuals even in their seventies and eighties appear to be as intact, psychically, as is the normal young adult. Others, even in their seventies, may already show signs of presenility or even of senility.

The Rorschach does not appear to have been used widely with old people, either in clinical or in research studies, and the literature on this subject is sparse. Among the most useful studies, the reader is referred to Klopfer (5), Prados and Fried (9), Dörken and Kral (4), and Chesrow, Wosika, and Reinitz (3) as well as to our own earlier publications (1, 2). This literature presents chiefly means and other group trends. Furthermore, since most subjects were tested only once, there is a great dearth of information about what happens to the Rorschach of the older person as he ages. Regardless of how he compares to other old people, or to mature adults, on a first test, it is important in improving our understanding of the aging psyche to know what happens to the response of any given older person as he continues to grow old.

The present study is a longitudinal approach to the study of the aging psyche as revealed in successive Rorschach protocols in six old people aged from 70 to 97 on the first test, each subject re-tested at approximately 2-year intervals. For four subjects we have available three tests each; for a fifth we have four tests; and for a sixth, six tests. Age of subjects on their last tests ranged from 75 to 102 years.

Preliminary review of data, in the light of what we already know of the Rorschach response of the elderly subject (1, 2) suggests the following hypotheses:

That the general tendency in perhaps the majority of individuals is toward

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an increasing restriction of responses with increased age—lower N, higher F%, lower F+%, lower M and lower sC, higher A%, and decreasing number of content categories.

However, that in certain well-endowed and well-preserved elderly individuals the response though inevitably showing some restriction, tends to stabilize and then to develop in a manner especially characteristic of well-preserved old age. Thus the response may show decreasing F%, increasing F+%, increase in H and in M—especially in interpersonal M—and the giving of abstract or idealistic responses.

That although most subjects, no matter how well endowed or how well preserved do show signs of presenility in the seventies or at least in the eighties, in the best-preserved individuals the response may not deteriorate into senility in the late eighties, nineties, or even past one hundred.

B. Subjects

Subjects for this study were six out of 61 elderly subjects over 70 years of age for whom more than two Rorschach records, at no less than two-year intervals, were available. These subjects were selected on the basis of the total number of records available (i.e., three or more apiece), but all had also in common that each lived in his own home and was responsible for his own affairs.

Sex and age at time of examinations are given in Table 1.

TABLE 1
Sex and Age of Subjects

1 male subject with examinations at 83, 85, 88 years
1 male subject with examinations at 97, 99, 102
1 female subject with examinations at 70, 72, 75
1 female subject with examinations at 77, 79, 82
1 female subject with examinations at 76, 78, 81, 84
1 female subject with examinations at 77, 79, 82, 84, 86, 88

Educationally, subjects may be classed as follows, though it must be remembered that education for women was not offered as freely when these subjects were young as it is today (Table 2).

As to occupations, three of the four female subjects were grade school teachers. One taught until she was married, one until time for retirement, the third until she became a primary school principal in 1919. The fourth woman worked as a court stenographer until the time of her marriage. One of the men was the head of a science department at a large University.

TABLE 2
EDUCATION OF SUBJECTS

1	business school
1	high school or its equivalent
3	normal school
1	Ph.D.

The other, a business man, held responsible positions with Fox Films and other similar organizations.

Thus as compared with the total population (1, pp. 15-16) these subjects are considerably above the national average for persons of this age range, both educationally and occupationally. According to earlier studies (5, 6), individuals with higher ability or educational level at younger ages tend to "hold up" better in psychological performance in old age.

C. FINDINGS

1. *By Variables—Total Group*

a. Number. All six subjects decrease in number of responses through the years, though in some instances this decrease is variable, as reference to Tables 7 to 12 will show. Mean for the group decreases from 24 to 20 to 17 to 11.

b. Area. There is as with subjects of all ages, great variability in this respect. Except for Mr. W., in whom D responses predominate at all ages, all subjects shift from a predominance of D responses to a predominance of global (four subjects), or from a predominance of global to a predominance of detail (one subject). Dd% tends to decrease or to disappear. Mean W% increases irregularly; mean D and Dd% decrease.

c. Form. F% decreases in all but two subjects. This decrease for the most part seems to be caused by a relative increase in the amount of movement. Mean F% decreases, then increases, then decreases sharply.

d. Correct form. F+% decreases in four subjects, increases slightly in two. In both of these, the increase in correct form is brought about by a decrease in number of responses determined by form alone—in one instance there is only one pure form response. This increase in enlivenment, chiefly in movement responses, actually hides in some instances a decrease in correct form, since some of the movement responses are of poor form. Mean F+% decreases from 92 per cent on the first two tests to 90.5 per cent on the third.

e. Movement. If we consider merely the flat number of human movement responses, direction of change in our several cases is variable: three increase, two decrease, and one stays the same over the total age range in question. However, if we consider the relative number of human movement responses to the total number of responses, human movement increases in five of our six cases, and in the other decreases only slightly. Mean M increases from 2.7 to 3 to 5.

Animal movement increases in actual number in two cases, decreases in three, stays the same in one. In relative number it increases in four cases, stays the same in one, decreases in one. Mean FM increases on the first three tests from 3 to 3.5 to 4.3.

There is a tendency for human movement to decrease relative to animal movement, with increasing age. This tendency appears in three of the six cases. In one other the ratio remains at 1M:4FM.

f. Color. Color responses in this group of cases are minimal. In two cases, sC is zero for both first and last tests in the series; in one it remains even at 1sC; in one it decreases from 1sC to 0sC; in one decreases from 5sC to 0sC, and in one from 2½sC to 0. Thus in general the trend is either a decrease, or no color at any time. Mean sC decreases from 1.6 to 1.2 to 0.

g. Shading. Number of shading responses decreases in five subjects. The sixth gives no shading on any test. Mean F(C) decreases from 2 to 1.8 to .3 to .5.

h. A%. The trend here is variable. Four subjects increase in A% as they grow older; two decrease. Mean A% follows an uneven course.

i. H%. Human per cent increases in all subjects, and mean H% increases steadily except that the mean for Test 2 exceeds that for Test 3.

j. Number of content categories. Though our expectation (1) is that the number of content categories will decrease with age after 70 or so, in this group only three subjects show a decreasing number of content categories, two remain the same, one increases. Mean number of content categories is five in each of the first two tests, four on the third, and three on the fourth.

k. Populars. Mean P% for the group increases steadily on the first three tests. This increase is seen from Tests 1 to 3 without exception in all of our subjects except Mr. W. whose P% declines steadily as follows: 27 per cent, 20 per cent and 17 per cent.

Mean scores for all variables for all tests are given in Table 3. Tables 7 to 12 give scores for each subject on each test. These scores are given in full because they constitute the heart of this study, showing quantitatively exactly what happens to the response of each subject with increasing

TABLE 3
MEAN SCORES FOR MAJOR VARIABLES

Variable	Test 1	Test 2	Test 3	Test 4*
N	24	20	17	11
F%	57.5%	43.3%	56%	3.5%
F+%	92.2%	91.8%	90.5%	100%
M	2.7	3	3	5
FM	3	3.5	4.3	2.5
m	1	1	.8	1
FC	.5	.3	—	—
CF	.8	.8	—	—
C	.3	.2	—	—
sC	1.6	1.2	—	—
F(C)	2	1.8	.3	.5
A%	50.5%	48.5%	56.8%	30.5%
H%	16.3%	23.5%	20.8%	47.5%
W%	39.8%	47%	45%	69%
D%	48.0%	45%	48.5%	30%
Dd%	12.1%	8%	6.5%	—
No. of content categories	5	5	4	3
P%	26%	34%	38.5%	34.5%

* Six subjects on each of the first three tests; only two on the fourth test.

age. Their inclusion seems particularly important because to date, longitudinal data on very old subjects are extremely rare.

2. *A- and B-List Changes*

In our earlier study of Rorschach responses in old age (1), we identified 57 items or ways of responding which especially characterize the responses of elderly subjects. These have been divided into two groups: A-list items, or those ways of responding found earlier, in childhood, which largely disappear in maturity but which reappear in old age; and B-list items which appear first in old age or which at least have never been given conspicuously at earlier ages.

Table 4 shows the extent to which these items occurred in records of our present subjects. Since there were three tests each on six subjects (Test 4 on Mrs. J. and Tests 4-7 on Mrs. E. were omitted here), the total possible number of subjects who could give each sign is, obviously, six, and the total possible number of times the sign could occur was 18. Only signs which appeared in records of three or more of our six subjects were listed in Table 4. The number of times which each type of sign occurred in each of our subjects is shown in individual Tables 6 to 11.

TABLE 4
A- AND B-LIST SIGNS WHICH APPEAR IN THREE OR MORE OF THE SIX SUBJECTS

Sign	No. of subjects using	No. of times used in all three tests	Identification of sign
A-1	3	5	Thinks own concept right or wrong
A-2	5	10	F% over 50%
A-3	4	8	A% over 50%
A-8	4	11	$M + FM = 0$
A-9	4	7	Give qualifying remarks
A-12	4	12	$FM >$ or $= M$
A-14	3	5	Interest in other people's responses
A-16	5	13	Qualifying verbs—could be, might be.
A-17	4	8	Initial exclamations
A-20	3	6	Low R (15 or fewer)
B-1	5	7	One or more anatomy responses
B-3	3	5	Abstract or idealistic responses
B-4	4	7	Quarreling response
B-5	5	9	H% of 15% or more
B-7	4	9	Complain that their brains aren't good etc.
B-9	5	10	0 sC
B-15	3	4	Much laughter
B-19	3	7	Discusses own response with self
B-45	4	9	Prefaces response with "Well!"

The impression was gained that the better-endowed, more highly educated, and best-preserved subjects might be expected to give more B-list than A-list items and vice versa. This was suggested on the grounds that the less well endowed or less well-preserved old person might be most likely to return to a childish way of responding, whereas the better endowed and better preserved might be the ones who would stabilize and develop in a new direction with old age.

Judgments as to which of our subjects fall into which category are extremely subjective, but on the basis of our acquaintance with these subjects, we would rate Mrs. E., Mrs. J., and Prof. R. as the best-endowed and best-preserved; Miss K., Miss S., and Mr. W. as perhaps the least. In each of the three former, B-list items do predominate; and in the three latter, A-list items.

3. *Nature of M*

One of the outstanding characteristics of the Rorschach protocols of the elderly subjects of this study is the relatively large (and in several subjects increasing) number of human movement responses. And of these M responses, an outstanding feature appears to be the large proportion which reflect some degree of interpersonal engagement. (It is a rather sad commentary that at a time of life when interpersonal relations tend to be largely lacking or at best unsatisfactory and unrewarding, that they should mean so much to the individual. Perhaps it is because they are lacking that they loom so large in the Rorschach.)

TABLE 5
% OF M RESPONSES WHICH INVOLVE INTERPERSONAL ACTIVITY

	Test 1		Test 2		Test 3		Test 4		Test 5		Test 6	
	All M	%	All M	%	All M	%	All M	%	All M	%	All M	%
Mrs. E.	7	57%	7	85%	6	83%	3	100%	5	80%	5	100%
Mrs. J.	6	66%	4	75%	5	80%	7	100%				
Miss K.	2	—	2	—	1	100%						
Miss S.	—	—	4	50%	1	—						
Prof. R.	—	—	2	100%	1	100%						
Mr. W.	1	—	1	—	1	100%						
All M	16		20		15		10		5		5	
Mean % Interpersonal		30%		51%		77%		100%		80%		100%

Table 5 indicates the extent to which the M responses of our subjects are concerned with interpersonal activities.

As this table shows, percentage of all M which involve interpersonal activity ranges from 50 per cent to 100 per cent. In four of the six cases, M becomes increasingly concerned with interpersonal activity, as does also mean M for the group.

Next we are concerned with the nature of these characteristic interpersonal responses. Thirty-three of the total of 71 of the M responses given by present subjects fall into one of two categories—either two people arguing, competing, or not liking what the other is doing; or engaged in a friendly discussion. There are 17 arguments or competitions; and 16 friendly discussions—46 per cent of all M.

The inter-animal (FM) movements do not for the most part suggest as strong a degree of involvement between the two animals as most of the human movement responses suggest between the two humans. However, with some of the older subjects, FM strongly resemble M in their degree of involvement. Thus Mr. W. at 102, on his third test, gives this response on Card III:

> A nice bird. It isn't one of our hen-hawks or a gull, too stout for that. But a bird all right. This one is settin' on the nest and that one don't like it. This fellow's better than the other one here.

And Mrs. E. on her third test, at 88, gives such responses as:

> Card VI: "Well, those are two animals but almost human intelligence.

And it's almost is if they were discussing something in a friendly way. Not a danger but something, some pleasure they anticipate." (Says this very sincerely.) "Very slight difference of opinion between them—paws two different ways. But that won't lead to any angry words—they're quite congenial."

Card VIII: "Well all I see is just these two bears. Do bears eat leaves and things?" (If they're hungry enough, probably.) "They're evidently both very hungry. And I think they're a little bit suspicious of each other. Each thinks that the other is trying to get the nourishment on his side."

4. *Emotional Tone of Responses*

All responses for all subjects were classified as friendly-pleasant-agreeable; neutral; or angry-hostile-dangerous-unpleasant. Neutral concepts predominate in all subjects in the first three tests, and for the group as a whole on all tests (except Test 6 of Mrs. E.) For most subjects at most ages, pleasant concepts come second, and predominate over unpleasant. However, unpleasant concepts become increasingly conspicuous, and on Mr. W.'s third test and on Mrs. E.'s sixth predominate. On Mrs. J.'s third and fourth tests, unpleasant nearly equal pleasant concepts. These findings suggest that in the psyche of the aging individual, gloomy or unpleasant, hostile or threatening concepts play an increasing role.

5. *Sex Differences*

Rather conspicuous sex differences have been determined as existing and evident in the Rorschach responses of very old people (1, p.124). The chief differences are that females give more responses, a higher D%, more M, more F(C), more color. Males have a higher mean W%, higher F+%, more m, higher mean H%, higher P%. These differences exist in normal, presenile, and senile subjects.

With only two male subjects and four females in the present study, sex differences are not particularly significant, but the following can be observed. As in our earlier subjects, females do give higher N, many more M and FM, more color. Males have a generally higher F+%. Shading and inanimate movement are about equal. Other differences do not agree with earlier findings, in that females here give a higher W%, higher H%, generally higher P%; and males give a higher D%, higher F%, higher A%.

6. *Individual Cases*

a. Mrs. A. E. Mrs. A. E. is our best-documented subject, with Rorschach protocols available at 77, 79, 82, 84, 86, and 88 years—six records covering an 11-year period. Like other subjects in this group, Mrs. E. lives independently in her own house. She is both physically and mentally active—doing her own shopping and gardening, looking after her own financial affairs, and for recreation, reading widely and enjoying double acrostic puzzles. She is also considerably interested in politics and until she was 84 worked at the polls as an election clerk.

Her health has been excellent except for a severe cerebral hemorrhage when she was 86, just before her fifth examination. She was hospitalized and not expected to live, but after two months in hospital and nursing home, returned home. Her 86-year-old Rorschach was given while she was still convalescing, and her Rorschach response anticipated her return to virtually her full earlier degree of activity.

This full series, covering more than 10 years of this well-endowed and resilient subject's later life, gives us the clearest view which we have yet obtained of the changes which take place in the human psyche with increasing age. As will be seen, a marked change, in the direction of simplification, takes place between 77 and 79 years of age. Thus N is reduced from 38 to 14; area shifts from primarily detailed to primarily globa; F% is sharply reduced; F+% is increased, and relative amount of M is sharply increased. Color drops out. A% is reduced.

The Rorschach picture then remains remarkably static from 79 through 86 years (see Table 6), with N ranging only from 11 to 16, area remaining predominantly global, M and FM numerous, no color, low F (range from 15 per cent to 37 per cent), 100%F+ at every age, and content categories ranging from 3 to 5. Then, following her illness at 86 years of age, the response becomes slightly more vigorous and in many ways more like that seen at 77 years than at any other time thereafter. N increases, response becomes again predominantly detailed, A% is lowered and color comes in.

And then again at 88 years, as earlier at 79 years and following, a slight deterioration sets in with W% increasing and again predominating, color dropping out, A% again increasing, and number of content categories reduced. However it should be noted that even here at 88 years of age this subject gives 14 responses, 100%F+, 5M, 6M, and 53%H.

Mrs. E., like even the best-preserved elderly subjects, shows some inevitable signs of increased restriction as she grows older. Thus over a 10-year period from 77 to 88 years her N decreases from 38 to 14, color drops out, A% increases from 36% to 57%, number of content categories decreases from 7 to 2. However, there is much in her series of responses which shows stabilization and expansion. Thus F% decreases from 52 per

TABLE 6

	Mrs. A. E., 77-88 years					
Variable	77 years	79 years	82 years	84 years	86 years*	88 years
Number	38	14	16	11	13	14
Area	18%W 55%D 27%Dd	57%W 35%D 8%Dd	50%W 44%D 6%Dd	72%W 27%D	46%W 54%D	57%W 43%D
F%	52%F	29%F	37%F	27%F	15%F	7%F
F+%	92%F+	100%F+	100%F+	100%F+	100%F+	100%F+
Movement	7M 4FM 1m	6M 3FM 1 tend m	6M 3FM 1 tend m	3M 3FM	5M 2FM	5M 6FM 1 tend m
F(C)	1 F(C)	0 F(C)	1 tend F(C)	1 F(C)	1 tend F(C)	0 F(C)
Color	2FC 1CF 2C	—	—	—	0FC ICF 1C	—
A%	34%A	29%A	44%A	45%A	30%A	57%A
H%	37%H	50%H	44%H	45%H	46%H	43%H
No. content categories	7	5	3	3	4	2
No. A-list signs	4	4	3	3	3	3
No. B-list signs	8	11	8	8	5	8
Classification	Normal to intact presenile	Intact presenile	Intact presenile	Intact presenile	Intact presenile	Intact presenile
P%	21%	28%	31%	36%	38%	36%

* At 86 years, Mrs. E., about three months before Test 5, suffered a severe cerebral hemorrhage and was not expected to recover. However, she did recover and fully resumed her normal life and activities.

cent to 7 per cent; F+% increases from 92 per cent to 100 per cent. Relative number of both human and animal movements increases . . . H% increases from 37 per cent to 53 per cent. Classification changes between 77 and 79 years from normal-intact presenile to intact presenile, and remains at intact presenile for the next nine years. At every age, B-list signs far exceed A-list signs, though both are strongly present at every age.

Most characteristic of her response at all ages is the consistently high H% (37 per cent to 53 per cent), and the predominance of strongly interpersonal human movement responses (57, 85, 66, 100, 80 and 100 per cent of M at successive ages are interpersonal). The nature of this engagement varies from extremely pleasureable: (III) "Two very self-satisfied gentlemen going for a walk and having a grand time," to extremely hostile: (II) "Oh I see real animosity in the faces of these two people."

An example of the changing interpersonal interest is shown in her responses, at successive age levels, to *Card IX:*

77 years

DW $\overset{\nearrow \text{CR}}{\text{M}}$ (H)	"Another bright one. Certainly looks like witches having a grand old time. Throwing things back and forth and catching, though I don't see what it would be. Up in the tops of trees. Pink is a bright flowerbed down there underneath the trees." (Inquiry: The witches in the trees and the color below made me think of flowers.)
Dd $\overset{\nearrow \text{m}}{\text{F}\pm}$ obj. O	"Ropes on a vessel." (Inquiry: Green claws into pink? The number of different ropes which hang on a vessel.)
Dd F(C) Hd O	< "Profile, face, eye, nose, beard and headdress. What I thought was an eye is a button on the side of the hat." (? Unusual small detail, dependent on shading, where green and orange mix.)
D F+ Hd	"Pink man with moustache or side whiskers, his eye is quite plain and his collar. Looks like Taft. The elder Taft. Kind of stout."

79 years

D M H	"That's a gay old pair. I think they're monks having a grand drink. I bet they're talking about people who have confessed to them and laughing about it." (? Orange as monks, holding up glasses and drinking.)
D F+ H	"Can you see two things, disconnected, in one picture? Two men, moustaches, heads too big and eyes, good-natured. Too bad their bodies are so small." (Inquiry: usual figures in pink).

82 years

D K H — "Well I should think by the fingernails they must be Chinese; isn't it the Chinese who have such long fingernails? They're pointing with their thumbs (top proj.) each to his own fingernails, each thinks that he has the longest." (Else?)

Dbl F+ obj. — "Two little statues there (white in gray) but I don't seem to see why they're there." (Don't have to.) "Oh I thought it had to be all together."

84 years

DW M H O — "Well I think they're wise men having a discussion. With many gestures. I suppose wise men would be amiable but they don't look too amiable. I have an idea they're having a contest. They climbed up there to see how long they could stay in that precarious position."

86 years

D CF plant
D C plant — "Well that's undoubtedly two witches. *Couldn't be anything else!* Their tall pointed caps. And very angry. (?) Well by the way they're gesticulating . . . I can't tell what they're holding. They're evidently up in the trees, aren't they? (?) They're green and the way people are perched in them. Grass and flowers beneath—looks vertical but probably horizontal."

88 years

D M (H)
D FM A — "Well those are two witches aren't they? I can't tell anything except they're having a heated dispute. All I can see. (?) Oh yes. Oh! Some why some . . . animals . . . fierce with their mouths open. (Usual deer). Perhaps the people are just discussing their danger and trying to point out to each other something they may do to escape." (This whole card could be scored DW MH).

More than any other subject, perhaps, Mrs. E.'s responses reflect what we may assume to be her own personal problems and attitudes. Thus consider the response to Card X, on Test 4:

> Ha ha! Two small animals (top gray). I don't know what kind. They've climbed up those very steep places (pink). And now they're afraid. And they're hanging on for their very lives. Talking it over and each says, 'How long can we hold out, and *who* will come to our aid?'

Or, the response to Card V on the 5th test:

> Bird with very heavy wings. He seems to be trying to rise from the ground but it's very difficult. He's getting one wing up a little higher than the other already. But he's a very patient bird and he'll keep on trying.

Or again, response to Card IV on the 6th test:

> Well this is apparently a terrible ogre. He's in a tearing rage. He's lifting up his voice to heaven and complaining about the way people are treating him and each other. He's sure the whole world is coming to destruction and he's utterly helpless to prevent.

Mrs. E.'s chief interest and concern as reflected in this series of Rorschach protocols thus appears to be interpersonal relations—how individuals (rather than Mankind as in the case of Mrs. J.) get along. Extremes both of excellent rapport and of great enmity and competition are expressed—in the earliest years friendly relations predominate, but in the later years, hostility.

b. Mrs. L. J. Here again is a well-documented case, there being available four successive tests at ages 76, 78, 81, and 84 years. The first of these tests seems to fall well within the normal category; subsequent tests suggest intact presenility. This subject exhibits great psychic vigor throughout, appears to enjoy the test and responds to it enthusiastically and without any of the self-deprecating comments so characteristic of subjects in their late seventies and eighties.

Mrs. J. attended business college and before her marriage, at the age of 25, was a court stenographer. She has always been a vigorous woman and at one time belonged to the "Hundred Mile Club"—a club in which membership depended on having bicycled 100 miles a day. She is the mother of five and has four grandchildren. She is still extremely vigorous, alert and interested in all that goes on around her.

Mrs. J. is perhaps our best example of an elderly subject whose response shifts from the normal to the presenile category but at the same time remains vigorous with little change back to the kinds of responses seen in childhood. That is, the response appears to stabilize with age and to develop in a somewhat new direction.

As Table 7 indicates, her response becomes less in number and in variety of content, slightly more global, and completely introversive. However, other signs of presenility (higher F, markedly lower F+, decreased enlivenment and higher A%) do not appear. Rather, F% decreases and finally on the last examination drops out entirely, and every single response becomes enlivened (7M, 2 FM and 3 m out of 12 responses).

The clearest impression of Mrs. J.'s changing response can be obtained from a study of Table 7 which gives her scores on all four tests, and from the changing response on selected cards.

TABLE 7
Mrs. E. J., 76-84 years

Variable	76 years	78 years	81 years	84 years
Number	25	16	25	12
Area	52%W 44%D 4%Dd	56%W 44%D	28%W 68%D 4%Dd	66%W 33%D
F%	52%F	44%F	32%F	0
F+%	96%F+	71%F+	81%F+	—
Movement	6M 4FM 1m	3M 5FM 1m	5M 12FM	7M 2FM 2m
Color	1CF	—	—	—
F(C)	1 tend.	1 tend.	—	—
A%	36%A	56%A	68%A	16%A
H%	32%H	31%H	24%H	50%H
No. content categories	7	4	4	3
No. A-list signs	3	4	4	5
No. B-list signs	8	10	7	7
Classification	Normal	Normal to intact presenile	Intact presenile	Intact presenile
P%	28%	31%	24%	35%

Card I

76 years

WS F+ anat.	Skeleton of a museum piece, dinosaur, first and third vertebrae, upper. (Reminded you?) These white spots look like the column goes through.
D M Hd	Little hands, like the baby, reaching out to go.
D F+ H	Now it looks different. Form of a woman, don't see the sides. (Centered figure.)

78 years

DW M abstr.	I've forgotten about it—it's what imagination I have about this picture. I really can't say I see anything . . . Now I see, it's coming to me now—something. Looks like a flight or ambition—what is it—something grasping something. It's all I can see. (?) The center seems to grasp for something; it's upward, reaching out. The sides are just sort of a protection and embrace—I suppose approving the flight.

81 years

Dd F+ Ad	It can be horns, these are (sides, middle).
D FM A	Eagles up there, flying eagles—are flying—wings spread.
D M H	Reaching out to shake hands, to be brotherly, hands trying to reach each other friendly trying to reach a goal, friendly. Trying to reach a goal—haven't met yet—like we and the Soviets.

84 years

D M Hd	. . . These two things reaching for something (demonstrates). Confidence and assurance there (right). These heads (right) confidence—goal. Reaching with confidence they are going to . . .
D FM A	Bird with tail stretched out (upper right).
D m abstr.	This is strife. Life I suppose it would be. (Mid-right).

Card X

76 years

D F+ A	Now what's that? Oh I see, mice. (side brown).
D F+ A P	Crabs. (side blue).
abstr. ↗ DW FM A	Wet marsh, new life, polliwogs. (? Center orange). (Reminded you?) Whole thing gives me a feeling of water and new life. (?) Shape.
D F+ A	They're on dry land. Moles? (Gray). (?) Shape.
abstr. ↗ DW F+ arch.	A bridge—don't know what that red means. Bridge between two factions—maybe it will mean peace. (?) (Center blue is bridge.)
W m abstr.	(?) I think it must represent evolution. (Whole card.)

78 years

DW F+ abstr. D F+ A D F+ A P D F+ A D FM A comment D F+ A	Oh this is a gay one—more animals. All sorts. This looks like all life with animals. There's the bison (top gray) and the crab (side blue) and the dogs (center yellow) and ∨ a deer because of the leap (side brown). Well and you can't help but see balance even in the little center (orange) there, and worms (lower green). My, everything is here. Well, it's just a picture of life isn't it? (Note: this could have been scored without the D's for separate items.)

81 years

D FM A P D F+ A	∧ < ∨ < ∧ This looks like a happy picture. It's gay, the animals, the bugs seem friendly, that is not fiercesome. These big spiders. These could be a water bug. These up here don't look so friendly. But they're little, they stand like a chicken but their tails. What are these spiders shooting off—might be some poison (green) maybe.

D FM A confab.	(Upper center) They might be fighting to get across that piece of chasm. "You go first." "Let me go first." Whether these spiders are going to help them across is a question. These little polliwogs (brown on side) not troubled at all. And I don't know what this center means, may mean everything is so even it will reach
Abstr.	perfection.
Abstr.	See the balance up there (center seed pods). Yes, you can't tell those little—woodchucks might be (upper center) want to get
D FM A	across there, can't tell what they're saying. . . . Green, poison, might be sending advice, how to cross the chasm.

84 years

W m abstr.	That looks like evolution. All these things have come starting. See these two duffers smoking their pipe like papa had. (Blues). They're evolving—a pair up there. That's the way it was—nothing complete.

Mrs. J. shows some clearcut and perhaps inevitable restriction with increasing age. N decreases from 25 to 12, F+% from 86 to 81 per cent, color drops out, number of content categories decreases from 7 to 3. And her record changes classification from normal, to normal-intact presenile, to intact presenile.

However, in spite of these changes, she presents a good example of an individual whose response in many respects stabilizes. Thus F% decreases from 52 per cent to 0 per cent, movement increases and is throughout strongly interpersonal (66, 75, 60, and 57 per cent in succeeding tests), A% decreases, and H% increases. Furthermore, B-list signs predominate over A-list signs. The direction of change is toward presenility, but toward a vigorous rather than a restricted presenility. The outstanding and rather unusual aspect of her response is the increasingly large proportion of abstract responses which she gives (8, 18, 16, 33 per cent), as well as the strong expression of interpersonal engagement.

Her chief interest or concern appears to be the state of the world and the general betterment of mankind. She seems to be approaching the end of life with the feeling that life is good and that there is much hope for humanity.

c. Miss M. K. Miss M. K. is our youngest subject, with tests at 70, 72, and 75 years of age. Except for minor signs of presenility in Tests 2 and 3, this might almost be the record of any normal elderly individual.

Miss K. is a vigorous, healthy, enthusiastic woman who at the time of the first test had just retired from the position of elementary school principal which she had held for 30 years. She finds retirement "exciting.

Time to catch up with everything I want to do. Life seems full—so many interesting things." Of her health she reports that her doctor told her that her physiological age was about 60. On the second and third tests, as well as the first, she continued to be matter-of-fact, hearty, agreeable even though with a slightly heavy wit. She lives alone in the upstairs apartment of a two-family house which she owns. She manages all her own affairs and appears to be extremely self-reliant.

Her first test shows virtually no signs of presenility. In subsequent records she shows slight signs of aging and of perhaps the first stages of intact presenility. On Test 2 for instance, she shows the following signs suggestive of beginning presenility:

She thinks her own concepts are right or wrong.
She tells her own experiences.
She gives "quarrelling" responses.
She complains that her brains aren't good.
She questions the Examiner as to what the "answer" is.
She gives physical excuses for poor performance.
She tells a story about bats.

Test 3, however, does not show conspicuously further deterioration.

Considering the three tests in sequence, Miss K. shows the kind of general age changes which we often find in intact subjects in their seventies—as presenility begins: decreasing N, increasing F%, decreasing F+%, lower M, decline or dropping out of color, increased A%. Whether or not she will later reach a plateau of stability or will become increasingly restricted only time will tell.

Age changes on specific cards are not particularly noteworthy except for the loss of color on the third test. Though Miss K. shows a slight spurt on her second test in some variables, in general the trend is in the direction of restriction.

This subject—our youngest—gives the fewest responses of any. She also has the fewest A- and B-signs of anyone and those she gives are weighted heavily on the side of A-list signs. Though her H% increases slightly, she gives only one interpersonal M and in this the interpersonal engagement is slight: "Alphonse and Gaston, two very polite gentlemen, each of whom tries to outdo the other by letting him go first."

There is little that is outstandingly individual about this record. P% is high throughout—35, 39, 54 per cent. Miss S., though well preserved and vigorous and enthusiastic, is also our most banal and quite probably our least well-endowed subject. She does not give a strong flavor of presenility.

TABLE 8
Miss M. K., 70-75 years

Variable	70 years	72 years	75 years
Number	17	18	11
Area	76%W 24%D	66%W 33%D	63%W 37%D
F%	18%F	39%F	63%F
F+%	100%F+	93%F+	92%F+
Movement	2M 3FM 1m	2M 1FM 1m	1M 2FM 1m
Color	1FC, 2CF	1FC, 2CF, 1C	—
F(C)	4F(C)	3F(C)	—
A%	59%A	44%A	63%A
H%	11%H	12%H	18%H
No. of content categories	4	7	3
Classification	Normal	Normal-intact presenile	Normal to intact presenile
No. A-list signs	7	3	8
No. B-list signs	1	4	7
P%	35%	39%	54%

Nor of individuality. Her many banal responses give a picture of an adaptable, conventional person who goes along with the crowd, comfortably and effectively but without original thought or concern beyond the affairs of everyday living.

d. Miss M. S. Miss M. S., one of the younger subjects, was seen at 77, 79, and 82 years of age. During the year preceding the third test, she reports that she was subject to three coronary attacks. Miss S., retired after 51 years of successful teaching, is active with club work. She keeps house for herself—the downstairs apartment in a two-story house which she owns. A large woman, a mesomorphic endomorph in build, she seems vigorous and cheerful.

Her three successive records have all been classified as intact presenile. Her records change with age in a somewhat conventional way, though the change from the first test to the last is not large in most respects. The test response at 79 years (Test 2) appears somewhat fuller and more vigorous than that at 77, but then (after the three coronary attacks) falls off slightly at 82.

N, which is high at all ages, increases and then decreases. Response becomes increasingly global, with Dd dropping out entirely. As Table 9 indicates, there is unquestionably a slight spurt and improvement at 79 years over the

TABLE 9
Miss M. S., 77-82 years

Variables	77 years	79 years	82 years*
Number	25	28	18
Area	28%W 44%D 28%Dd	46%W 46%D 8%Dd	55%W 45%D
F%	72%F	32%F	55%F
F+%	94%F+	100%F+	100%F+
Movement	0M 2FM 2m	4M 7FM 2m	1M 3FM 3m
Color	1CF	2CF	1CF
F(C)	2F(C)	4F(C)	0F(C)
A%	56%A	43%A	45%A
H%	8%H	14%H	16%H
No. content categories	5	4	5
No. A-list signs	9	7	4
No. B-list signs	6	5	1
Classification	Intact presenile	Intact presenile	Intact to medium presenile
P%	28%	36%	50%

* Three coronary attacks at 81 years.

response at 77, but if we consider merely the second and third tests, we find for nearly every variable that the record becomes less full and more restricted.

The improvement on the second test is noteworthy. Changes between Tests 1 and 2 are chiefly in the direction of expansion: higher N, lower F, higher F+, more movement, more color, more shading, lower A%, higher H%. However, changes between Tests 2 and 3 are in the direction of restriction: lower N, higher F, less movement, less color, less shading. As to A- and B-list signs, except for Miss K., Miss S. has the fewest of any subject. At all ages they are predominantly A-list signs.

Of her five movement responses, only two are interpersonal—dancing and waving goodbye. Though Miss S. did in some ways make a "better" response on Test 2 than on Test 1, she does not seem to settle into the stabilized and expanding pattern of the better-endowed old people. Expectations are that subsequent responses may be considerably more restricted than those already obtained.

High A% in part prohibits there being any outstandingly individual flavor to her response. Perhaps most characteristic is the predominance of highly personal remarks: "Looks like Chessie's (her cat's) tail," or "Posts on my bed." The large number of directly personal responses give the impression of a woman who though vigorous and clear is primarily concerned with herself—strongly oriented toward her own interests and concerns.

e. Professor L. R. Professor L. R., a former University department head, lived at home with his wife and daughter, in a nice private house, and though retired, went to his office almost daily until the time of his death, shortly after his third Rorschach. He appeared to be clear and alert even though his behavior was characterized by a certain self-centeredness and by the loquacious reminiscences characteristic of older people. He was rated presenile on all three examinations.

Though Professor L. R. is unquestionably the best educated of our six subjects and very likely may originally have been the most highly intelligent, his response is the sparsest of any. It is to be expected that the response of a man in his eighties may be less extensive than that of a woman in the same age group. This somewhat sparse response may reflect either basic individuality characteristics or may indicate an advanced presenility.

Even on his first test at 83 years, this subject is more restricted and considerably less productive than the mean expectation for this group. Like several of the others, he does show a marked improvement on the second

TABLE 10
Mr. L. R., 83-88 years*

Variable	83 years	85 years	88 years
Number	11	10	9
Area	45%W 55%D	40%W 50%D 10%Dd	66%W 33%D
F%	81%F	50%F	86%F
F+%	83%F+	100%F+	87%F+
Movement	0M 1FM	2M 3FM	1M 0FM
Color	—	—	—
F(C)	1F(C)	0F(C)	0F(C)
A%	45%A	50%A	55%A
H%	0%H	20%H	11%H
No. content categories	2	4	5
No. A-list signs	7	4	6
No. B-list signs	6	10	5
Classification	Intact presenile	Intact presenile	Intact presenile
P%	18%	50%	55%

* Died at 89 years.

test, and then Test 3 shows marked deterioration both as compared with Test 2 and with Test 1. Comparing the first test, at 83 years, and the last one at 88, shortly before his death, Test 3 is less in number of responses, more global in area, more restricted and less accurate, and has a higher A%. There are two refusals on both. The one area of improvement is that there are five different content categories in Test 3, only two in Test 1.

In an earlier study (1) we found that many very old people tend to give either a preponderance of anatomy or a preponderance of animal responses. Prof. R. gives 55 per cent anatomy, 45 per cent animal at 83 years; 20 per cent anatomy, 50 per cent animal and 20 per cent human at 85 years; 11 per cent anatomy, 55 per cent animal (and several other responses) at 88 years. Thus he has made a clear shift from a preponderance of anatomy to a preponderance of animal responses.

Age Changes in an Individual Card

Card IX

83 years

G F— A Sometimes I don't know whether I want to use glasses or not. Read a whole book yesterday without glasses. For proper names I need glasses but the familiar words I can see without. Did they use different colored inks here? Some of this reminds me of down in Charlestown years ago at the—Hotel, there came up and crossed the floor a large animal. Mrs. L. said what is that? I said an Irish elk. But the waiter stepped on it. It was really only a roach. The antennae up here make me think of that.

85 years

Dd F+ Ad That looks like the horn of one of the horned deers. I don't seem to get much of any other help here. See I seem to see them largely in terms of animals. That's about the only suggestion I have—antler of big moose or something of that sort. (Inquiry: center spike on orange.)

88 years

— I think it's too bad to do this in the presence of my wife. Her idea of my intelligence goes down! These weren't made like the old way, but one is the mirror image of the other. Necessarily so. Somehow just parts fit rather than the whole. Trouble with the different colors. I'm a little apt to specify in my mind one of the different colors and not take it as a whole. Is it proper to say you don't know?

Professor R. expresses the common restrictive course of aging individuals in his slight decrease of N, increase in A%. However, he shows more expansive, stabilizing characteristics as follow: F% decreases and F+% increases, M and FM increase, H% increases and content becomes more varied. These changes occur chiefly between Tests 1 and 2. Test 3 is somewhat more restricted than Test 2. Both A- and B-list items are fairly prominent. A-list items predominate in Tests 1 and 3; B-list items in Test 2.

This is not a particularly individual set of records. Outstanding characteristics are high A% (45, 50, 55 per cent), conspicuous anatomy (55, 20, 11 per cent) no color, midline emphasis, the extent to which his professional field (paleontology) influences his responses (lungfish, crab, skull, shoulder girdle, occipital conduits, etc.). His three M—two on the second test and one on the third—are mildly interpersonal.

Professor R's responses thus in many ways fit the hypothesis that the Rorschachs of elderly men tend to be less enlivened than are those of elderly women. This subject in his series shows himself to be primarily concerned with the words and concepts of his profession. Neither the nature of his work nor his primary concern with it could be seriously questioned on reading over his Rorschach protocols, though they tell us relatively little about his emotional state or his interpersonal interests.

f. Mr. G. W. Mr. G. W. is our oldest subject—seen at 97, 99, and 102 years of age. His response remains in the reasonably intact presenile category, throughout. His manner—extreme loquacity and a tendency to get off the track and to tell about long-past events—makes him appear less intact than does his actual response to the cards.

Mr. W. had held a series of responsible positions, the last of which he began at the age of 90 and from which he retired at 95. He married his second wife when he was 70, and they had a daughter three years later. Mr. W. remembers riding on an election train with Abraham Lincoln, but his life is by no means all in the past. Until his death at the age of 103 he was healthy, active, and lived in his own home, walking downtown, and going to New York to appear on T.V. panels. He was the dominant figure in an apparently happy though simple home, and attracted much attention from newspapers and from local groups because of his age.

The vigor of Mr. W.'s response, even at 102 years of age, seems remarkable, and as Table 11 indicates, age changes are not marked. Remarks characteristic of presenility are prominent on all three tests. (Test I): "Perfect buffalo hide!"; "If I ever saw a bat, there's one right there." "Puts me in mind of a story." (Test II): "I've seen them fellers in the

TABLE 11

Mr. G. W., 97-102 years*

Variable	97 years	99 years	102 years
Number	30	35	24
Area	20%W 66%D 14%Dd	17%W 62%D 21%Dd	8%W 64%D 29%Dd
F%	70%F	66%F	63%F
F+%	88%F+	87%F+	83%F+
Movement	1M 4FM	1M 2FM 2m	1M 4FM 2m
Color	—	1FC 1CF	—
F(C)	4F(C)	4F(C)	2F(C)
A%	73%A	69%A	66%A
H%	10%H	14%H	12%H
No. of content categories	5	7	5
No. A-list signs	10	10	10
No. B-list signs	10	6	4
Classification	Intact presenile	Intact presenile	Intact presenile
P%	27%	20%	17%

* Died at 103 years.

woods," "What a long tail our cat's got!" "Bet you won't get another answer in a thousand like this." "Perfect head of a St. Bernard dog." (Test III): "Ho ho! I don't know why they should hide their faces!" "Oh now we go to the horned people." "Perfect image of a ham."

Typical age changes with age occur on Card IV, as follows:

Card IV

97 years

Dd F(C) Hd	Now we have got something here. Spilling whole bottle (of ink) on this one. Came near making a good lobster of it but you spoiled it. Face. (Show inside).
P G F(C) A/obj.	∧ ∨ ∧ I tell you what that would make nicely. (Covers part.) Take a buffalo, strip his hide off and there you've got his skin there. Perfect buffalo's hide stripped off. I've seen maybe 3,000 buffalos at once. Not many; some people have seen 5,000 or 6,000. So much fur there too, that's what gets me.

99 years

■
↗
G F+ Ad P

∧∨ Well, now let me see . . .∨ Huh. (Smiles). Now I'll tell you what that resembles to me more than anything else—and I'll bet you won't get another answer in a thousand like it—no other person will answer like that. This looks just like a buffalo skin taken right off the buffalo, and I'll tell you why. I've seen a buffalo herd of 300,000 on the plains—they were killing buffalos for the Union Pacific, and they sent the skins here. (Tells about stretching skins.) Here's the flank and here would be the buffalo's head (lower center), there's his flank, of course that's cut off but that's the way it would look when you're through—that would look just like that. (Inquiry: whole with head at lower center.)

102 years

—

Now that's funny, I don't like that. This goes up the back (midline). Mmm! (Long pause. Holds it off and considers it.) Now! Has the body of one of our buffalos, but it isn't right for a buffalo. No! No! I couldn't make anything of that.

With respect to scoring variables, Mr. W's responses to the three successive tests do not change in a consistent direction. However, in general they may be summarized as follows. Changes in a restrictive direction include decreasing N and slightly lowering F+%. However, most variables seem to remain about the same, or change in an expansive direction. Extraneous verbalization, personal comment and reminiscence, decrease slightly with age.

A-list items predominate over B-list items. As Table 11 shows, there are 10 A-list items, and nearly the same items, on each test. B-list items decrease. Mr. W. shows more of these A- and B-list items than does any other subject.

M is very sparse and only on his third examination does the one M indicate interpersonal engagement. However on Test 3, three of his four FM are of an interpersonal (or interanimal) nature.

Mr. W.'s responses are most conspicuous as records of an aging individual who even past 100 years of age maintains relatively consistent intact presenile status, falling off very little with age. In fact to some extent he stabilizes and shifts into the expression of interpersonal engagement characteristic of apparently the most highly endowed and best preserved old people.

His actual responses and scoring give the impression of vigor and intactness, but the high A% rather obscures any picture of individuality. There are a surprisingly high number of responses throughout—24 even at the age of 102.

D. Discussion

One of the most striking aspects of the Rorschach records discussed in this paper is the relative intactness, force, and vigor of the aging psyche seen in this reasonably representative group of elderly subjects. Subjects were selected on the basis of being the only six out of an original population of 200 on whom we obtained a series of three tests each, at intervals of no less than two years. Of course, subjects had to stay alive in order to be available, and that is to some extent a selective factor. Also they had to be willing to continue to take these tests. This willingness is in itself somewhat selective, as some of our original subjects, though still alive and well, refused retesting with the comment, "I don't see that this test does me any good."

However though perhaps somewhat exceptional, if simply on the basis of longevity and adaptability, we may consider that our subjects are not in every way exceptional and that there are many other elderly individuals whom proper testing (as with the Rorschach) would show to remain extremely clear and alert mentally even into their eighties and nineties. The implications for employment and industry are evident. It seems very certain that compulsory retirement at a set age is arbitrarily relegating to disuse much useful human potential.

Specifically as to the Rorschach response, it appears likely (1, 2) that perhaps the majority of elderly subjects as they age become increasingly restricted. The common trend—and this appears to be shared by all, even the most resilient and best endowed—is toward a decrease in N, a decrease in variety of content categories, and a decrease and eventual dropping out of color responses, with increasing age.

The implications are clear. The aging individual gradually limits (or is limited in) the sector of experience to which he can respond, in his ability to be stimulated by the environment; and the vividness and depth of his emotional response. (We see this in the apparent shallowness yet lability of the octogenarian who goes from laughter to tears in a space of seconds and seems little affected by either: "I buried three lovely wives" (tears); followed by chuckling and the comment, "They sure feed us mighty good here.")

A large proportion of elderly subjects also show as they grow older a higher F%, a lower F+, lower M and FM, and a higher A%. This, along with the decreased N, little or no color, and a lessening number of content categories, yields an extremely static, stereotyped, and restricted picture of the psyche of the aging individual.

However, there appear to be some elderly subjects (namely here Mrs. E., Mrs. J., and to some extent the two men), who though inevitably showing some of the restriction common to old age, do tend to stabilize in their Rorschach response and then to develop in a manner specially characteristic of well-preserved old age. That is, instead of increasing, their F% decreased;[1] F+ increased; and both human response and human movement—especially interpersonal movement—came in strongly. Or the response is even expanded in the direction of abstract or idealized responses. But even though the response may be said to be stabilized, the low F and high interpersonal M response does reflect a loss of contact with the environment and objectivity and overconcern with personal matters, especially with interpersonal relations. In fact it may go so far as to represent a flight into fantasy, away from reality.

Since color as well as shading is rapidly disappearing or has already disappeared, it is predictable that movement responses would increase with decreasing F. However, the sharp increase in F+% may come as more of a surprise. Observing the several ways in which this is achieved can give a useful insight into the intellectual and perceptual functioning of the aging individual. Among the most common devices for the maintaining or increasing of F+% are the following: increased number of refusals, lowered N, F— movement responses, increased A%.

As is true of any behavior test, with the Rorschach a series of examinations, at intervals, gives a much clearer picture of the status of the subject than does a single test. Often it is the direction and rate of change which interests us quite as much as the absolute level of response. In old age Rorschach responses, the clearcut trend observable in many subjects is toward restriction and deterioration of response. However, as a review of the tabulated scores in Tables 6 to 11 shows, the trend in any given individual over a period of years is not invariably toward such restriction and deterioration. In addition to those subjects whose records stabilize, on occasion a subject gives a "better" response at an older age than at a younger. Among our subjects, the following exceptions to the rule of gradual deterioration of response occur: Miss S. gives a response which in some ways seems better at 79 than at 77; Mrs. E.'s gradual deterioration over a 7-year period is stemmed temporarily *after* a severe cerebral hemorrhage at 86; Mrs. J. seems better at 81 than at 78; Mr. R. seems better at 85 than at 83; Mr. W. is a little better in some respects at 99 than at 97.

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[1] Expected F% in normal adults is generally expected to be between 20 and 50 per cent. An F% below 20 per cent suggests insufficient attention to the immediate physical and social environment. "Everything that happens around such subjects assumes a significant personal importance for them and clouds their judgments for they are generally unable to maintain a detached indifferent and objective attitude toward anything" (8, p. 102).

Since in four of these five instances the slight improvement comes on a second test, followed by subsequent restriction and deterioration on a third, the possibility is suggested that the very old individual may approach a new experience such as the Rorschach test with suspicion which may to some extent cut down on the excellence of his response. When the test is given for the second time he may feel more secure with it. But that even this security, which may account for slight improvement, cannot interfere seriously or permanently with the expression of a general decline of intellectual function.

The customary trend, assuming that an individual lives long enough and deteriorates far enough is from normal adulthood to presenility to senility. However many even quite long-lived individuals do not proceed very far along this path. Among present subjects, who range in age at the time of the third test from 75 to 102 years of age, none declines farther than intact presenility.

E. SUMMARY

A series of from three to six Rorschach tests were given at approximately two-year-intervals to six elderly subjects, aged between 70 and 102 years. Subjects were selected from a larger population of over 70-year-old individuals, chiefly on the basis of availability. All subjects were alert, independent, and vigorous, living in their own houses and taking care of their own affairs.

Tables of means as well as of all scores for each subject are given. Scores of these relatively well preserved subjects (all rated as "normal" or "intact presenile" on every test), show a common trend toward restriction of response. All show a decrease of N, decrease in variety of content categories, and a decrease or eventual dropping out of color with increasing age.

Like subjects reported in earlier studies, several of the present subjects show the further restriction of an increasingly high F%, increasingly low F+%, lower M and FM, and high A%.

However, several of the subjects though inevitably showing some of the restriction characteristic of increasing age, tend to stabilize in their response and then to develop in a manner which may be specially characteristic of

well-preserved old age. For these individuals, F% decreases, F+% increases, and both human and animal movement, especially interpersonal movement, comes in strongly. Nearly half of these interpersonal movement responses fall into one of two categories: two people either arguing, disputing, competing, not liking what the other is doing. Or engaged in friendly activity or discussion. FM to some extent reflects the same kinds of involvement.

Or, the response may expand in the direction of abstract or idealized response. Increase in F+ is brought about by decreased N, increased refusal, increased A%, or by the hiding of poor form in M scores.

Special kinds of responses characteristic of presenility (A-list items or ways of responding common in childhood, absent in maturity, reappearing in old age; and B-list items or ways of responding absent or infrequent in childhood and normal adulthood but appearing in old age) are conspicuous in present subjects. B-list items predominate in the better-preserved subjects.

Slight sex differences are observed in that females give more responses, higher D%, more M, more F(C), more color. Males have a higher mean W%, higher F+%, more m, higher mean H%, higher P.

Though the majority of responses are neutral in emotional tone, unpleasant concepts become relatively conspicuous in relation to pleasant concepts, as subjects grow older.

The predominant trend with increasing age is toward restriction, but on occasion a later test may be a little "better" than an earlier test. Though the customary trend is toward presenility and eventual senility, many long-lived individuals do not appear to proceed far along this path.

In spite of the increased restriction characteristic of old age, and the similarity of response, in some respects from one subject to another, the Rorschach appears even in extreme old age to be a useful tool for revealing individual personality characteristics.

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DISCRIMINATION REVERSAL LEARNING BY CATS*

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A. PROBLEM

The objectives of this experiment were to determine whether cats could acquire a set to reverse discrimination responses to a sign not involving an unreinforced response, and to investigate the effects of maintenance food deprivation upon reversal learning and spontaneous activity in cats.

It has been shown (Riopelle and Copelan, 1954) that if reversal of the stimulus-reward relation is signalled by the substitution of a yellow for a green stimulus tray, rhesus monkeys learn to reverse their choices on presentation of this cue, thus solving reversal problems without error. Response reversal to a change in the color of the stimulus tray was rapidly generalized to colors other than those used in original training, suggesting that "change in the background" came to act as a sign denoting reversal.

Meyer (1951) found that the performance of rhesus monkeys on discrimination reversal problems, and ratings of their locomotor activity, did not change significantly with differential food deprivation. The deprivation times studied were 1, 23, and 47 hours. Warren and Hall (1956) confirmed this negative result with monkeys tested on more difficult discrimination tasks. Similarly, Birch (1948) found no significant relation between the performance of chimpanzees on patterned string tests and periods of deprivation over the range from 2 to 48 hours.

In contrast to the results obtained from primates, there is a positive relation between the efficiency of learning by rats and deprivation interval, within the first two days of starvation (Munn, 1950). Rats also show a marked increase in spontaneous activity within a few hours following the onset of food deprivation (Richter, 1922).

The present research was undertaken to permit qualitative comparisons of sign learning and responses to food deprivation in rat, cat, and monkey.

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B. METHOD

1. *Subjects*

The 21 cats studied in this experiment had been thoroughly tamed and had participated in two previous experiments (Cronholm, Warren and Hara, 1960; Warren, 1959).

2. *Apparatus*

Discrimination reversal learning was observed in the Wisconsin General Test Apparatus (Harlow, 1949). The discriminanda were 80 pairs of wooden objects, varying in multiple visual dimensions.

Measures of spontaneous activity were obtained in a cage modelled after that described by French and Harlow (1955). Two intersecting beams of light divided the 30″ by 30″ cage into four equal quadrants; interruption of either beam activated a photorelay unit and the total number of beam interruptions was cumulated on a digital counter. The height of the beams was varied appropriately for tests with cats of differing size.

The activity cage was placed in a room without windows with constant artificial illumination from a fluorescent lamp on the ceiling. The following deviations in the arrangements for recording activity from French and Harlow's method should be noted. The cats were not tested in the presence of masking noise, so loud sounds from outside the test room could be heard by *S*. In addition, activation of the counter produced a clearly audible click in the apparatus used in this investigation, whereas French and Harlow's apparatus was essentially silent. These sources of error were constant for all *S*s, however, and it was considered unlikely that their influence would be so great as to mask gross differences in activity levels resulting from the experimental treatments.

3. *Procedure*

a. Discrimination training. In the WGTA, the cat must displace one of two stimulus objects presented on a movable tray. Displacement of the correct object uncovers a small piece of kidney, a very high preference food for cats, in a sunken food-well. Moving the incorrect object reveals an empty food well.

In order to evaluate the influence of stimulus preferences in discrimination learning, each *S* was required to select his originally preferred and non-preferred stimulus in an equal number of problems. On half of the problems (+), food was placed under both objects on the first trial. The cat was reinforced for choosing either stimulus on this trial and this initially preferred stimulus remained correct throughout discrimination training. In the remaining problems (—), there was no food under either object on the first trial. The object which was chosen on this trial was incorrect in subsequent discrimination training, and the cat was forced to respond to the initially non-preferred stimulus in order to secure the meat reward.

After the cat's first response defined the correct stimulus, training was continued until the correct object was chosen on 11 trials out of 12, with the last 8 trials all correct. Immediately after this criterion was met, the previously incorrect stimulus became the rewarded one and testing on this discrimination-reversal problem continued until the same criterion of mastery was attained.

The discriminanda were presented on a white tray to all cats during the discrimination phase of the problems, and the white tray was retained during the discrimination-reversal problems for the No Cue (NC) groups of cats. For the Cue (C) groups, however, reversal was signalled by replacing the white tray with a black one before the reversal occurred (and by the time interval required for this operation).

The animals were trained on 80 discrimination-reversal problems. An attempt was made to train the *S*s on one problem per day, but it was occasionally necessary to prolong testing on a single problem for two or more days, particularly in the very earliest stage of training when some cats required as many as 500 trials to reach criterion on both phases of a problem.

b. Deprivation. In order to obtain stable and unambiguous measures of the effects of deprivation on reversal performance, differential food deprivation was deferred until the forty-first day of the experiment. Until that time, all *S*s had continuous access to water and dry dog food (Friskies cubes) in their individual living cages. The non-deprived (ND) groups continued under this regimen. The deprived (D) groups were permitted *ad lib* feeding during the one hour immediately after testing in the WGTA and were therefore suffering from 23 hours' deprivation when tested the next day.

Activity was recorded during the 30 minutes just preceding testing on the learning problems; activity scores were obtained from all cats on Days 41 to 80 of the experiment. For the D groups, 22½ hours had elapsed since they had last had access to food.

4. *Design*

As implied above, four groups of cats were formed. The D-C group (7 cats) was deprived of food during the second half of the experiment and was provided with the cue that reversal had occurred throughout the experiment. The ND-C group of 8 cats differed from D-C only in that they were never deprived of food. The NC-D and NC-ND groups of three cats each were trained without the reversal cue, and differed in that they were, and were not, deprived of food, respectively.

Separate factorial analyses of variance were made of the number of errors to criterion on the pre- and post-reversal problems. These analyses permitted evaluation of the following effects and their interactions: Cue, Deprivation, Preference (half of the time the cats were rewarded for responding to the initially preferred stimulus, and half of the time they were not), and Problem Blocks; to determine the significance of learning, the experimental results were divided into four blocks of 20 problems each.

C. RESULTS

1. *Discrimination Learning*

Over the entire experiment there was no indication that the cats' preference or lack of preference for the rewarded stimulus had any effect on either discrimination or reversal learning, as illustrated by the fact that the animals averaged only 0.2 more errors in learning to select the originally nonpreferred stimulus in discrimination learning. Therefore, the preference factor is disregarded in the presentation of the results in Figure 1. Mean errors per problem are plotted against successive blocks of 20 problems with cue and deprivation conditions as the parameters in this figure. The panel on the left shows pre-, and that on the right, postreversal learning.

Inspection of these curves indicates that all groups manifested marked interproblem learning on both discrimination and reversal. The reduction in absolute error scores is larger on the reversal than on the discrimination problems. Yet there seems to be considerable constancy in the relative difficulty of the discrimination and reversal tasks throughout the experiment, so that on each problem block the cats made approximately twice as many errors on the reversals as on the original discriminations.

Neither cue nor deprivation conditions appear to have had any consistent effect on error scores. All four curves in both panels follow a roughly parallel course with frequent reversals of intergroup differences. The impressions gained from inspection of the curves are corroborated by the

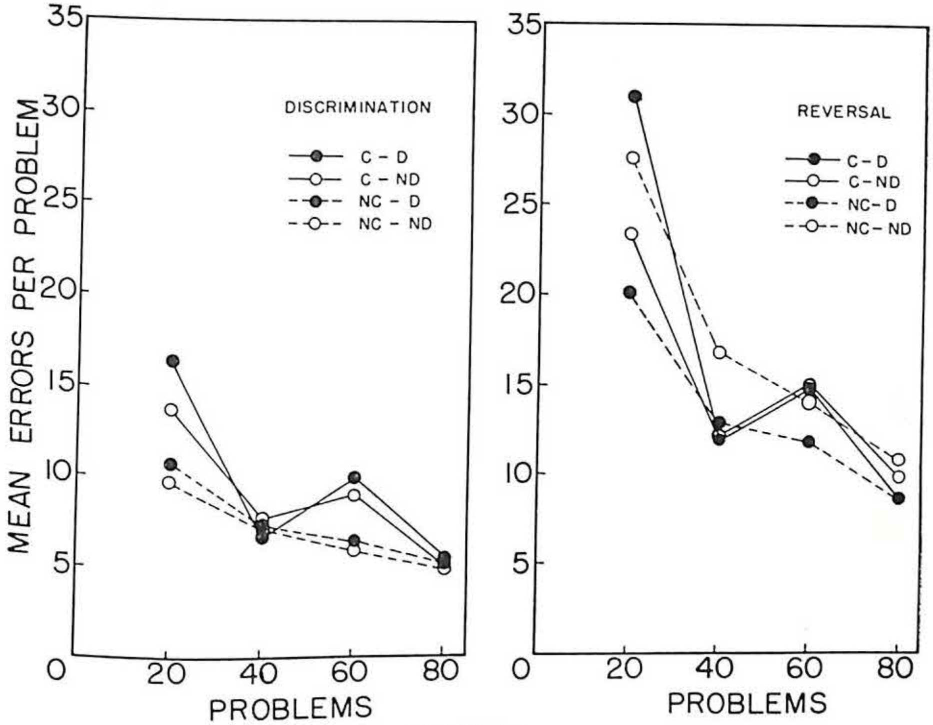

FIGURE 1
INTERPROBLEM LEARNING AS A FUNCTION OF CUE AND REINFORCEMENT CONDITIONS

analyses of variance. The only significant sources of variance are Problem Blocks (prereversal: F = 52, with 3/51 df; postreversal: F = 118, with 3/51 df) and those reflecting individual differences.

Intraproblem learning on the first and last quarters of training is shown in Figure 2. There are no large or consistent differences in performance by the C and NC groups on the first 20 problems. Both groups show a slow and irregular improvement on the discrimination problems, and both groups show less than chance success on the first 12 postreversal trials. On Problems 61 to 80, the performance of both groups on discrimination is virtually identical. Their curves rise regularly and to a stable terminal level which is considerably higher than that attained on the comparable discriminations early in training. The C and NC groups are, however, clearly differentiated with respect to success on the first two trials following reversal on this block of problems. But the advantage of the Cue cats is of short duration; the NC animals are not markedly inferior beyond Trial 4. It is apparent that reversal performance is greatly improved on the last stage of the experiment, since much higher than chance scores were made on the last six trials shown during the fourth quarter of training.

2. *Activity*

The effect of 23 hours of food deprivation on the level of spontaneous activity is shown in Figure 3, in which mean activity scores for the D and

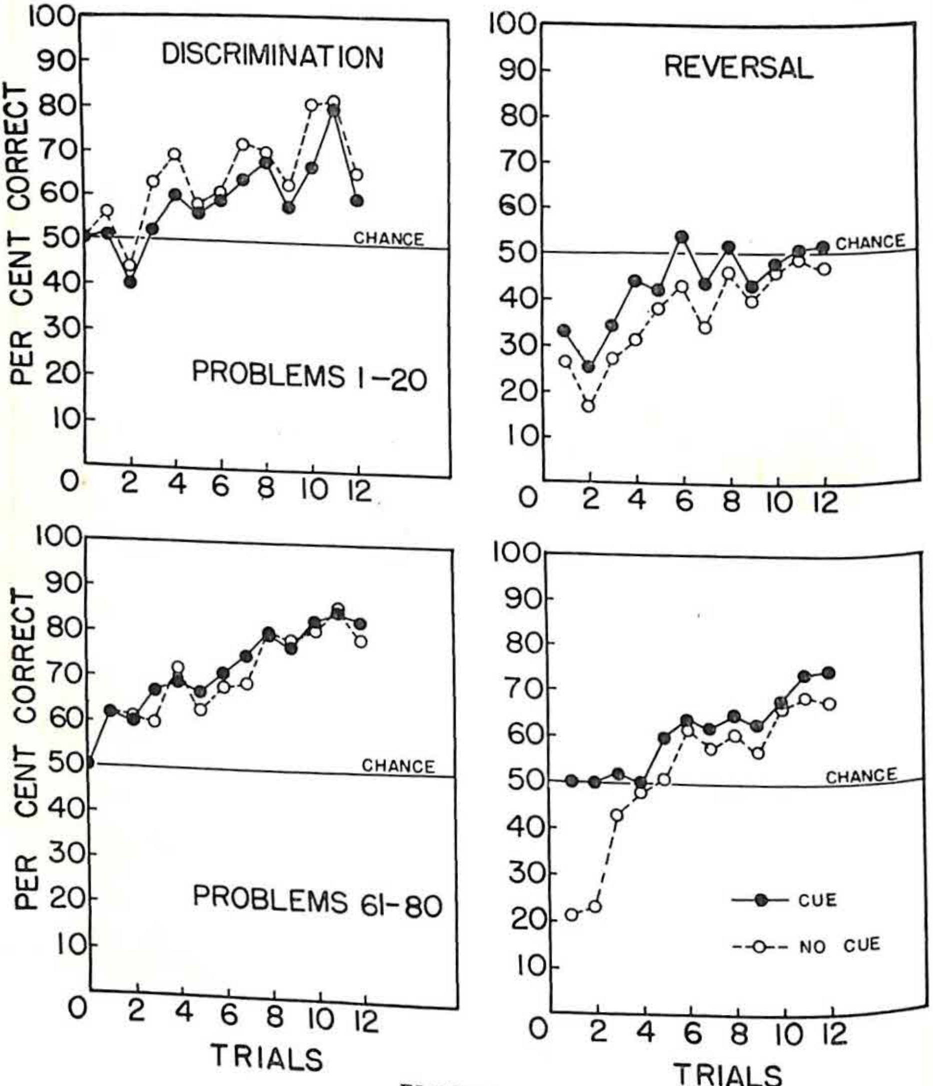

FIGURE 2

Intraproblem Learning on Discrimination and Reversal Problems on the First and Fourth Quarters of Training

ND groups are given for four 10-day periods. The scores of the D groups are slightly higher than those of the ND groups on the last three periods, but none of the intergroup differences approaches statistical significance.

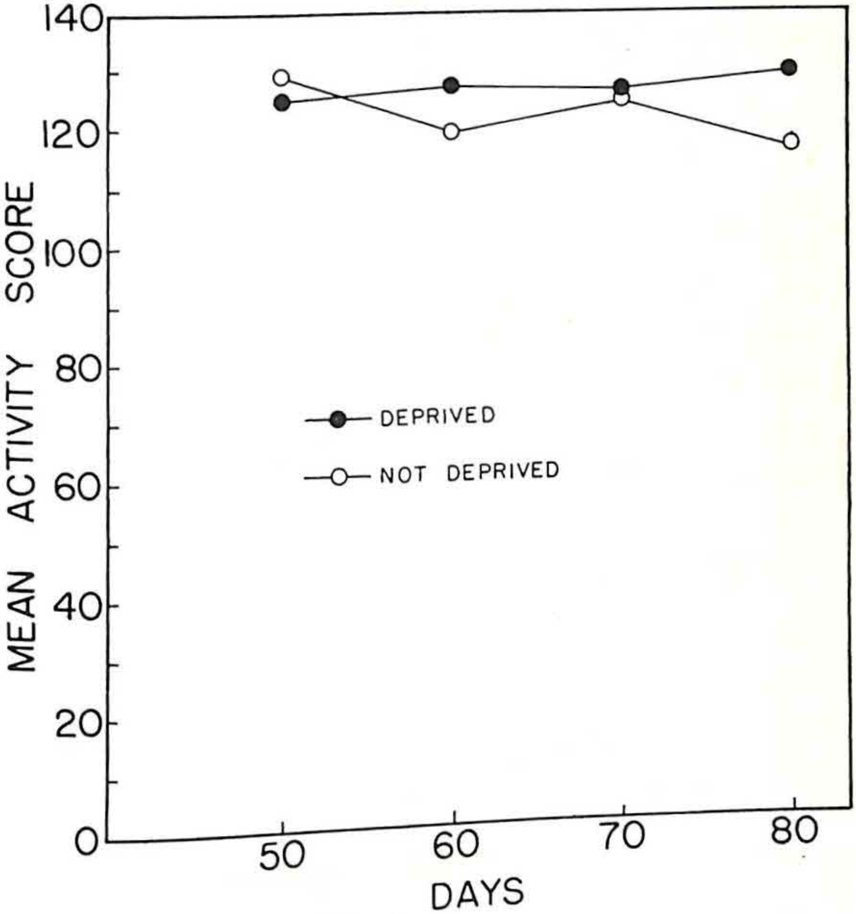

FIGURE 3
EFFECT OF 24 HOURS' FOOD DEPRIVATION ON ACTIVITY LEVELS

D. DISCUSSION

The results of this experiment indicate that, like monkeys, cats show a marked improvement in the rate with which they solve discrimination reversal problems; this finding confirms previous reports (Warren and Baron, 1956; Cronholm, Warren and Hara, 1960) that cats possess some rudimentary capacity for forming learning sets.

Two impressive differences in the discrimination reversal behavior of cats and monkeys are apparent in these data. Even with rather protracted training, cats do not approach the primate level of efficiency in discrimination and discrimination reversal; there is no indication that they could ever solve such problems with a single error. It is also patent that these cats failed to learn discrimination reversal to a sign. Their failure to do so cannot be attributed to insensitivity to the sign presented, since the Cue groups consistently made more correct responses on the first reversal trial than the No Cue groups did, and this difference increased with prolonged training. The differential performance of the C and NC cats on reversal Trial 1 probably reflects external inhibition, caused by the change in test tray brightness (and/or delay interval), of the inhibition of response tendencies to the incorrect stimulus (Harlow and Hicks, 1957) built up during the prereversal trials.

The lack of any difference between the cats' performance on discrimination problems in which the preferred and non-preferred stimulus was reinforced conflicts with previous observations that stimulus perseveration tendencies produce a marked increase in errors in discrimination learning by cats (Warren and Baron, 1956). Such perseverative effects were indeed previously found in the same subjects (Warren, 1959). It must be concluded that stimulus perseveration errors are eventually extinguished during the formation of learning sets by cats, and that this error producing factor in discrimination learning by cats is insufficient to account for the apparent incapacity of cats to manifest insightful solution of discrimination problems even after prolonged training.

In spite of the generally slower learning and inability to profit from a sign signalling reversal manifested by cats compared with monkeys, the cat's responses to food deprivation appear to be more nearly similar to those of laboratory primates than rats. Like rhesus monkeys and chimpanzees, but unlike rats, cats after 24 hours' food deprivation do not show significant increases in either spontaneous activity or efficiency of performance on learning tasks. The inference that the behavior of cats is less rigidly determined by homeostatic factors than is the case with rats is supported by the observations that resistance to extinction of lever pressing responses by cats does not vary with differential water deprivation (Smith and Smith, 1939), and that exploratory and manipulatory incentives never associated with food are adequate to motivate learning in kittens (Miles, 1958).

It might reasonably be objected that 24 hours of food deprivation is not as effective in producing heightened activity in cats as in rats because of obvious anatomical and physiological differences between the two animals. For example, the larger size, lower metabolic rate, etc., of cats enable them to survive continuous deprivation for much greater periods than rats. Conceivably, then, peak activity levels might not have been shown by the cats until they had gone many days without food.

In order to test this possibility, two cats were subjected to complete food deprivation for 20 days. These animals were tested in the activity cage described above for 30 minutes on each deprivation day, late in the evening to minimize exposure to extraneous stimulation and to control for cyclical variations in activity level.

One animal, No. 50, was tested for 20 days under nondeprived conditions; his predeprivation mean is indicated in Figure 4, which shows the daily activity scores of the individual animals under cumulative deprivation. Cat 50 shows a trivial increase in activity, on the order of 10 per cent, on the first three days of deprivation; thereafter, all scores are below the predeprivation mean and the terminal level represents a 90 per cent reduction from Day 1. The curve for Cat 55 is essentially similar. Only on the third day is his score higher than on Day 1, and the scores recorded

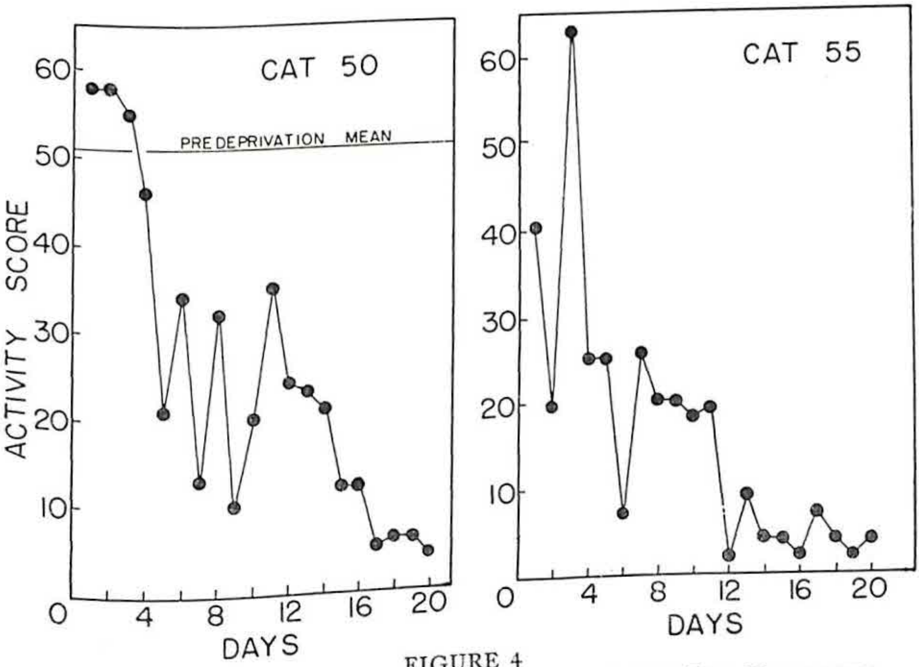

FIGURE 4
DAILY ACTIVITY SCORES OF TWO CATS UNDER CONTINUOUS FOOD DEPRIVATION

subsequently show an almost uninterrupted decline. These findings are consonant with the naturalistic observations of predatory behavior in cats, which consists of lying in wait for prey rather than pursuit as in canine forms, and indicate that there is no delayed access of activity in cats subjected to prolonged deprivation. Indeed, maximum activity occurs in the first three days, just as in rats (Richter, 1922). (It should be noted that both Cats 50 and 55 recovered completely after being returned to *ad lib* feeding.)

E. Summary

Twenty-one cats learned 80 discrimination reversal problems; on half of the discrimination problems the cats were required to choose the stimulus which was initially preferred and on the remaining problems to select the originally non-preferred stimulus. Four subgroups received differential treatments with respect to (*a*) the occurrence or non-occurrence of a change in test tray color from white to black when reversal began, and (*b*) 0 or 23 hours' maintenance food deprivation prior to testing. The effect of food deprivation on spontaneous activity was also studied.

The following results were obtained:

1. A marked and statistically significant reduction in errors to criterion on successive fourths of training was observed.
2. Food deprivation, presence or absence of a reversal cue, and initial stimulus preference had no effect on either pre- or postreversal performance measured in errors to criterion.
3. Food deprivation for 23 hours did not affect activity scores.

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THE PSYCHOSEXUAL IDENTIFICATION OF PRE-SCHOOL BOYS*

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A. PROBLEM

The make up of any culture is intrinsically interwoven with the concepts of masculinity and femininity. The social, economic, and interpersonal structure of society is based on this fundamental difference between the sexes. Throughout the history of mankind, many different theories have been proposed to account for the fact that human beings develop a concept of themselves as male and female. The differences that appeared to exist between psychological male and psychological female were at first accepted as a matter of fact and ascribed to the essential nature of men and women. Soon it became apparent that different cultures had different roles for men and women. Investigators such as Mead (10) discovered that there were some cultures in which women were not passive. There were cultures where men were not aggressive. The problem was further complicated by the discovery that despite the fact that most men differ from most women in various traits (20, 21), there are some men who are more like women in one or more ways than they are like men. There are some women who are more like men than they are like women. Roe writes that "the actual physical fact of maleness and femaleness is not necessarily an indication of location at the masculine or feminine end of the scale (14, p. 44).

The theoretical approaches to an understanding of the development of psychosexual identification can be placed on a continuum of emphasis and focus. At one extreme, the emphasis is placed on the internal forces operating on the individual. These include physical (8, 22) and intrapsychic (5, 6) explanations. At the other extreme of the continuum the emphasis is placed on the environmental, cultural, and social forces surrounding the individual (11). Despite the fundamental nature of the problem, relatively little systematic research has been done in the area of

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the development of psychosexual identification. Brown (3) has found preference patterns in young children that appear related to sex role. Brown (2) and Parsons (13) both implicitly relate the process of psychosexual development to the child's use of a parental model. Beir and Ratzeburg (1) hypothesize that a strong mother contributes to the lack of masculine feeling in a boy.

These studies, and others (4, 16, 17) appear to indicate that psychological maleness and femaleness is related to the process of identification. Furthermore, they emphasize that this process involves the relationship between child and both of his parents, although it is with the parent of the same sex with whom the child must identify if there is to be optimum identification. There have been indications that a disturbance of this identification process produces difficulty in the achievement of adequate masculinity and femininity.

Much of the research cited has been with adult or adolescent populations. Other research focused on sex-role differentiation. Relatively little has been done to explore the causally-related forces in the young child which lead to the development of sex-role and to the differentiation of preferences for sex-typed activities. The present research has attempted to investigate the influences in the psychosexual identification process in pre-school boys. It posed the problem of establishing the degree of acceptance of the respective psychosexual identification in a population of 30 pre-school boys and both of their parents. The study then investigated the relationship between the adequacy of sexual identification in the boys and the adequacy of sexual identification in their parents.

It was hypothesized that there would be a relationship between a boy's sexual identification patterns and those of his parents. This hypothesis was based on the theoretical premise that subtle and unconscious attitudes of parents regarding their own sexual roles are more crucially significant factors in the development of their children's sex roles than are parents' superficial or outwardly expressed behavior patterns. It was further hypothesized that boys who showed strong acceptance of masculine identification would have parents who showed a strong acceptance of their respective sex roles. It was finally hypothesized that boys who showed rejection of or weak acceptance of masculine identification would have parents who showed rejection of or weak acceptance of their respective sex roles.

B. METHOD

1. *Population*

The population consisted of 30 boys between the ages of four years and five and one half years, all attending one of four nursery schools in New York State. The population also included both parents of each boy, making a total of 30 mothers and 30 fathers. The boys were living with both parents at the time of the study and had not been separated from either parent for any appreciable amount of time. The families were all from the middle socio-economic group.

2. *Instruments*

In order to solve the problem of establishing the degree of acceptance of sexual identification in boys and parents a battery of three evaluative instruments was used for each individual. Each boy received teachers' evaluations on an Activity Preference Check List and on a Behavior and Personality Rating Scale, and then each boy was administered a Figure Drawing Test. Each parent filled out the Strong Vocational Interest Blank and the Terman-Miles Attitude Interest Analysis, and then each parent was given the Figure Drawing Test.

The Activity Preference Check List consists of a list of 21 activities common to nursery school programs. The list includes activities such as gun play, sewing, ball play, jumping rope, doll play, and other activities which could be classified as more masculine or more feminine. The determination of the masculinity or femininity of each activity was based on the judgments of competent authorities in the field of early childhood education, and was consistent with research findings in the area of children's play preferences. Each teacher was asked to designate the four most preferred activities for each boy. Each boy's score was based on the number of masculine activities preferred.

The Behavior and Personality Rating Scale consists of eight personality and behavior characteristics which had been found by this investigator, in a pilot project on 195 children, to differentiate boys and girls at a statistically significant level. The validity of these characteristics to differentiate between boys and girls has been further corroborated by researches by other investigators. The teachers were asked to rate each boy on a five-point scale on each behavior and personality characteristic. The score was the sum of the ratings on the eight characteristics.

The Figure Drawing Test was administered in accordance with the instructions suggested by Machover (9). The resulting figure that was drawn by each child and each parent was rated by three clinical psychologists using criteria of sex drawn and elaborating details. The ratings were based on a one to five scale where a rating of one represented low self-sex identification and a rating of five represented high self-sex identification.

The Strong Vocational Interest Blank is a questionnaire type of test which is designed to evaluate an individual's fitness for various occupations based on interests. The test can be scored for a masculinity-femininity scale which is incorporated within it. The responses are scored with a minus or plus score, and the sum of these scores represents a degree of masculinity-femininity as far as interests are concerned.

The Terman-Miles Attitude Interest Analysis is another test of the questionnaire type. This test is described by the authors as a "test of mental masculinity and femininity—which is based upon actual differences between male and female groups ranging in age from early adolescence to life's extremes" (21, p. 3). The test consists of seven subtests such as word association, information, and inkblot association. The individual is asked to respond to 456 items for Form *A* and 454 items for Form *B*. The two forms were used. Form *A* was administered to the mothers and Form *B* was administered to the fathers. The resulting total score represented a measure of masculinity or femininity.

3. *Administration*

In each cooperating nursery the parents were approached to enlist their aid in this study. They were asked to help investigate the relationship between the interests and other characteristics of children and the interests and characteristics of their parents. This was done in some instances at parent meetings of the nursery, and in other instances directly with individual parents.

Each couple was administered the Strong Vocational Interest Blank. When the parents completed the Strong Vocational Interest Blank they were given the Terman-Miles Attitude Interest Analysis. After the last page of the Terman-Miles test a sheet of paper was inserted with instructions to draw a picture of a person. These were the standard instructions for the Figure Drawing Test. When this test was completed and turned in, each couple was asked to complete a data sheet so as to evaluate socio-economic status, age, and whether or not there had been any separations from their child.

The teachers in the nursery schools were asked to fill out the Activity Preference Check List and the Children's Behavior and Personality Rating Scale for each boy included in the population of this research. The boys were then given a Figure Drawing Test, using the standard directions for this test (9). They were asked to draw a picture of a person. If the sex of the figure drawn was not evident or if it was not spontaneously verbalized, the boy was asked to tell something about the person. In this way the sex of the figure was determined. The children's instruments were filled out at mid-year. By this time the teachers were well acquainted with the children, as they were in daily contact with them throughout each week.

4. *Scoring*

The Strong Vocational Interest Blank was scored for the M-F scale. This was done by using the appropriate stencils supplied by the publisher. Each response is given a positive or negative value, and the result is a final score with a plus or minus value. A high minus value indicates high femininity while a high plus value indicates high masculinity.

The Terman-Miles Attitude Interest Analysis was also scored with the stencils supplied by the publisher. Each response is given a plus, a minus, or a zero. These correspond respectively to masculine, feminine, or neutral responses. As with the Strong Interest Test, the result is a total score with a minus or plus value. As is true of the Strong Test, high minus values indicate high femininity and high plus values indicate high masculinity.

The score on the Activity Preference Check List was based on the number of masculine activities checked. If four masculine activities were checked for a boy, his score was four. Scores of one, two, or three were obtained in the same manner.

The Children's Behavior and Personality Rating Scale was scored by totaling the ratings given each child on each sub-item. This total score then became the raw score for this instrument.

The Figure Drawings were rated by three clinical psychologists, one of which was this investigator. They were rated on a scale of one to five. The one end of the scale indicated a weak degree of self-sex identification while the five end of the scale indicated strong self-sex identification. In their ratings the clinical judges used criteria such as sex drawn, degree of clarity of sex anatomically, through clothing drawn, and the kind of accessories drawn (pipe, purse etc).

The scores on each of the instruments were converted to standard scores.

This was done in order to make it possible to combine and compare them in various ways.

C. RESULTS

The scores obtained by each boy and each parent on each of the evaluative instruments used in this study represents a measure of the degree of acceptance of psychosexual identification as measured by that instrument. Thus it was possible to derive a composite score by including the measures of all three instruments, and it was possible to derive scores based on individual instruments or any combination of instruments. These measures for the boys were then compared to the equivalent measures for the parents.

Pierson product-moment coefficients of correlation were computed between the boys' and their parents' composite scores of the three instruments, of the two most highly correlated instruments, and between the Figure Drawing scores. This procedure was followed by another in which the population of boys was divided into high, intermediate, and low masculine groups. The parents of the boys in the high group were compared with the parents of the boys in the low group as to the significance of the differences of their means. The means of the parents' scores were compared with the means of the boys' scores to note if there were any significant differences. Finally the mothers and fathers were divided into high, intermediate, and low groups insofar as degree of acceptance of sex role was concerned. The high, intermediate, and low masculine boys were then compared in a contingency table to note whether there was any dependence between the group in which the boy scored and the group in which the parent scored.

No significant relationship was found to exist between the boys and their parents on any individual instrument or combination of instruments. Coefficients of Correlation were —.15 between the boys' composite scores and the mothers' composite scores, and .15 for the boys' scores and the fathers' scores. Furthermore, it was noted that although the boys fell at significantly different extremes of strong and weak acceptance of masculine identification, their parents could not be distinguished from each other as far as their scores on these instruments were concerned. Boys showing high masculine identification may have parents showing high sexual identification to the same extent that they may have parents showing low sexual identification. The same is true of boys showing low sexual identification.

D. DISCUSSION

The consistently negative findings of this investigation have important theoretical and practical implications. As far as this population was concerned, degree of psychosexual identification in boys was in no way dependent upon the degree of psychosexual identification in their parents. Thus the subtle or unconscious expression of a parent's own sexual identification did not significantly determine the son's sexual identification. This is not to say that the parents' psychosexual identifications do not affect the boy's sexual identifications. It is simply stating that whatever relationship does exist, it does not find its reflection in a degree of adequacy of sexual identification in boys corresponding to the adequacy of sexual identification in their parents. The parent may be an identification model, but these findings lead to the conclusion that it is not a model in quantitative terms. Therefore the boy may use the various characteristics of the father or mother as models for various characteristics in himself, but this does not necessarily include the degree of adequacy among the configuration of characteristics that go into the make-up of masculinity or femininity. Thus he may model himself after his father's gruffness or tenderness, generosity or selfishness, interest in baseball or bridge. He may unconsciously pattern himself after his father in any combination of such characteristics. The actual characteristics manifested by the father may be either direct expressions of, or compensatory disguises for, weak masculine identification. The findings of this investigation indicate that the boy may identify with his father's outer appearances to no less an extent than he does quantitatively with the basic unconscious identification of his father.

There is no support for the conclusions of previous investigators to the effect that strong mothers contribute to the lack of masculine feeling in boys or that feminine mothers contribute to the development of masculine assurance in boys (10, p. 278). This study found that boys with weak masculine feelings had approximately equal numbers of mothers who were strong, weak, and intermediate. Furthermore, their mothers were no different in range of feminine identification than the mothers of boys with strong masculine feelings.

This research has attempted to touch on the issue of causally-related influences in the psychosexual identification process. To the extent that these findings are corroborated and generalized to other age groups they suggest that such a causal relationship is not to be found in the psychosexual adequacy or inadequacy of the parent. This conclusion has far reaching implications. The psychoanalytic, and notably the Freudian writers, have been persistent in their affirmations that unconscious parental attitudes are transmitted to their children and further, that psychic conflicts in parents find their reflection in their relationships to their children. It is readily apparent that both of these points are related.

Thus, a parent with unconscious conflicts revolving about his sexual identification would have unconscious attitudes colored by these conflicts and therefore would transmit these to the child regardless of attempted compensations or disguises. Moreover, psychic conflicts in parents, along with efforts at ineffectual, inappropriate, and neurotic solutions, are manifested in behavior toward children which is unconsciously designed to serve the needs of the conflict area. For example, a mother who is enmeshed in an unresolved Oedipus Complex may identify her son with her father and act in an unconsciously seductive manner toward him. In this way the boy's psychosexual development would be hampered. Therefore conflicts result in distorted attitudes, and both, according to Freudian writers, result in a disturbed developmental pattern. Fries (7, p. 92) writes that parental attitudes may prolong or shorten phases or stages of development in a child. Parents may cause fixation by too much or little gratification. This view is supported by Ruben (15, p. 247) who likewise states that disturbances in the mother, through unconscious attitudes influencing behavior, cause difficulty in the child's development.

The present investigation found that, as far as this population was concerned, the implied psychic conflicts that are concomitant with weak sexual identification in parents do not serve to decrease the strength of masculine identification in their sons. Nor did the implicit lack of psychic conflict, as far as the sexual identification area is concerned, in parents with strong sexual identification serve to facilitate the development of strong masculine identification in their sons. In the light of these findings the theoretical positions just cited do not appear tenable without further study of the issue. Those fathers who had weak masculine identification patterns should have transmitted their unconscious and deeper attitudes to their sons, and therefore have served as identification models of weak masculinity. If this process was not a primary influential force, then the psychic conflicts of which such weak identification is an expression, and which engenders further conflict in the individual, should have found behavioral correlates with depreciatory effects on the boy's masculine identification. This was not the case for this population.

This investigation has not intended to negate any particular theory of psychosexual development. Rather, as has been indicated previously, it has attempted to shed some light on factors influencing psychosexual development. Certainly they are not inconsistent with any of the biological, bio-social, or psychosocial theoretical formulations. Neither are they in opposition to Freudian theories of the Oedipus Complex or castration anxiety. The picture of the castrating father is in the child's mind and it need not be congruent with the true picture of the father. This applies to both the real father psychologically or behaviorally. Thus a fully adequate masculine father may appear as a threat to the child, but so may an inadequately masculine father. The feeling of threat results from the child's interpretation of the situation and his role in it. The father, or mother, may or may not, psychologically or behaviorally fit the picture of a threatening figure, and so alleviate or heighten the anxiety, but the focus of the anxiety lies within the child.

The significance of the findings of this investigation in relation to this point lies in the inferences which may be drawn. These would appear to cast some doubt on the relative dominance of the covert over overt factors in the parent-child relationship as far as influence on the development of the child's identifications are concerned. Although the resulting identification may be based in part on the parent-child relationship, it appears possible that sibling constellations and relationships, the training and educational methods used, situational factors external to the parent-child relationship, and other influences may play equally significant roles in the shaping of the identification patterns. It may be true, as Pierson's study indicates (12, p. 40), that parental attitudes may exert more influence than actual events, but attitudes and behavior, as far as those directed toward the child are concerned, may be at variance with the parents' own identifications. For example, a father with strong feelings of masculine inadequacy may wish to help his son avoid this problem. He may therefore encourage or pressure his son to build up masculine-typed skills. The pressure may cause psychic conflict in the child, but the developed skills may serve as a force toward stronger masculine identification.

As it has already been stated, the findings are not inconsistent with the various theoretical positions previously discussed. Yet, they lead this investigator in a direction which is closer to the psychosocial rather than to the biological, intrapsychic or socio-cultural points of view. The infant grows within a socio-historical framework which has, for each culture, defined roles, and given psychosocial meanings to biologically based drives. The infant is born with all of the physical and mental equipment of the specie, and with varying degrees of limiting forces of constitutional endowment that, in part distinguishes the individual. These needs and capacities, some common to the race, and some specific to the individual, then begin a process of acculturation. This process is one which involves the interaction of child, parent, community, and culture, all within the context of a changing history. As the infant grows and matures and learns, he seeks the most effective solutions to the satisfaction of his needs which are gradually being given differential meaning. Within the framework of psychoanalytic theory, this investigator sees the child as developing an ego and superego structure which enables him to meet his needs, deal with conscious and unconscious impulses, and fit into the social pattern. This development follows from the primary and inarticulated broad identifications he makes with his parents, along with the patterns of psychological defenses which the child finds best suited to his needs and circumstances. It is necessary to repeat the previously stated position that this interactional process includes the developing infant. Therefore there is a selectivity as well as a modifiability in the child's identifications and psychological response patterns. As a result a wide variation of personality correlates is possible from a similar experience.

This theoretical formulation and the findings of the present research are consistent with the theoretical position taken by Stoke (18). The results support his contention of a major distinction between emotional and behavioral identification. They likewise support Stoke's point that identification (including sexual identification) is the result of many factors rather than of either the organic factor alone or as related to the outcome of the Oedipus Complex. Thus he includes as potentially influential factors those based on biology, familial psychological patterns, social pressures, and relationships outside the family. When sexual identification is viewed from this position, the findings of this study may be readily understood. Similarly the findings of previous investigators who found that boys tend to identify with their fathers and girls with their mothers, are clarified. They may be discovering that boys identify themselves as male and then follow, to varying degrees, the model set down by the culture for the male. This model is before them in the form of psychological and behavioral father, other males who are significant figures to them, through molding pressures of words and attitudes of adults and peers.

These are some of the theoretical implications of this study. There are undoubtedly many more, but the very problem of psychosexual development is so complex as to necessitate a limitation of the discussion in this paper. Certainly it is important to investigate the implications of this study as they apply to other age and socio-economic groups, to girls, and with other instruments which may more adequately measure the deeper aspects of psychosexual identification.

E. SUMMARY

This study investigated the relationship between the degree of acceptance of masculine identification in a group of 30 pre-school boys and their parents' acceptance of their own respective sexual identification.

It was hypothesized that there would be a relationship between the degree to which boys accepted their masculine role and the degree to which their parents accepted their respective roles. Furthermore, it was hypothesized that this relationship would be a direct one.

Each boy was rated by his teacher on an Activity Preference Check List and on a Behavior and Personality Rating Scale. Each boy was then administered a Figure Drawing Test. Each parent was administered a Strong Vocational Interest Blank (from which the M-F score was obtained), the Terman-Miles Attitude Interest Analysis, and a Figure Drawing Test. Each of the instruments has been shown to differentiate males from females and provides a score on the masculinity-femininity continuum.

The resultant data were subjected to statistical treatment in which coefficients of correlation were computed, extremes of the distributions were compared, and the degree of dependence between boys' and parents' scores was determined using chi square in a contingency table. The following results were obtained and the following conclusions drawn:

1. No significant relationship was found between the sexual identification patterns of the boys and the sexual identification patterns of their parents.
2. Although the boys fell at significantly different extremes of strong and weak acceptance of masculine identification, their parents could not be distinguished from each other, nor from the general population insofar as their scores on these instruments were concerned.
3. Boys showing high masculine identification may have parents showing high sexual identification to the same extent that they may have parents showing intermediate, or low sexual identification. The same is true of boys showing intermediate and low sexual identification.
4. The findings of this investigation suggest that the psychosexual identification of parents is not directly related to the psychosexual identification of their pre-school boys.
5. The results appear to support a theoretical position which postulates the influence of many interacting forces on the individual as determinants in psychosexual development.

6. There is a need for further study in the area of psychosexual development with children of other ages and socio-economic groups, with a population of girls, and by means of devices which may measure deeper layers of psychosexual identification.

7. There is an evident need for clarification of the aspects and levels of conscious and unconscious sexual identification investigated in this and other research, and as used in clinical work.

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EFFECT OF ADRENAL DEMEDULLATION ON THE STARTLE RESPONSE OF THE RAT*

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A. PROBLEM

A recent paper by Moyer and Bunnell (in press-b) reported a significant positive correlation of .50 between the *S*s base lymphocyte count and the magnitude of the first of a series of startle responses. It is believed that emotional lymphocytosis may be caused by the endogenous secretion of adrenalin (Farris, 1938). Therefore, it is possible that the common physiological factor underlying both the lymphocyte count and the startle response is the level of adrenalin in the blood stream. Because of the rapid onset of the startle response after the startle stimulus, it is hardly likely that the magnitude of the startle response is a function of the adrenalin secreted as a result of the startle stimulus. However, there is the possibility that the base level of adrenalin differs in different *S*s and those with a higher base level of endogenous adrenalin give greater startle responses.[2] If this is true, we might expect the magnitude of the startle response to increase as a function of an increase in exogenous adrenalin. Moyer and Bunnell have shown that such an increase does not occur (in press-a). However, as they point out, it may be that exogenous adrenalin does not duplicate the action of endogenous adrenalin. Sharrer (in Abramson, 1956, pp. 167-168) indicated that adrenalin liberated by the medulla is liberated with a carrier which releases the adrenalin molecule slowly and that this situation is difficult if not impossible to duplicate.

Another way to test the possibility that adrenalin is a significant factor contributing to the magnitude of the startle response is to measure the startle response of adrenal demedullated *S*s. It is the purpose of this study to determine the effects of adrenal demedullation on the startle response of the rat.

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[1] This investigation was supported in part by a research grant M-1298 from the National Institute of Health, Public Health Service.

[2] There is some doubt as to whether the adrenal medulla actually produces adrenalin in the resting organism. It is generally agreed, however, that even a slight disturbance causes an increase of adrenalin output (Turner, 1955). In order to measure the startle response in the rat it must be picked up by *E* and placed in the apparatus. Thus, the organism is not in a complete state of quiescence, and *S*s may well differ in their adrenalin output to slight stimulation.

B. METHOD

1. *Subjects*

In this study 27 male, hooded rats from the colony of the Carnegie Institute of Technology were used. *S*s were between the ages of 140 and 145 days of age at the time of testing. Littermate control was used.

2. *Apparatus*

The apparatus used was a slightly modified form of the one described by Brown, Kalish, and Farber (1951). As in their apparatus, the sensing unit was a postage scale (Hanson Model 1509, 5 lb. capacity). The platform, dial, pointer, and protective glass were removed. The platform was replaced with a box 2¾″ × 6″ × 4″ with plastic sides and masonite ends. The top was also of masonite. The floor of the box was composed of brass rods 1/16″ in diameter spaced ¼″ apart. When a *S* was placed in the confining box and subjected to a sudden auditory stimulus, the startle reaction of the animal caused the platform to be depressed. The downward movements of the platform were transmitted by a thread and pulley system to a lever recording pen on a Phipps and Bird recorder. The recorder was set so that the paper moved at a rate of .15 in. per sec. The startle stimulus was produced by a toy pistol (Super Nu-Matic Paper Buster Gun) held 6″ over the confinement box.

3. *Procedure*

Forty-five days prior to the beginning of the testing period, nine of the animals were operated on and a bilateral adrenal demedullation was performed following the procedure described in Farris and Griffith (1949). Ether was used as an anesthetic. A sham operation was performed on nine *S*s. The procedure for this operation was exactly the same as for the adrenal demedullation. An incision was made in the skin and in the muscle tissue so that the adrenal glands were exposed. They were not disturbed, however. During this time, the non-operated control group of nine *S*s remained undisturbed in their home cages. Food and water were available to all *S*s ad lib.

In recording the startle response, each *S* was placed in the confining box of the startle apparatus and was given a period of 15 sec. of acclimatization time. The paper buster gun was then held 6 in. above the cage and fired. This initial shot served to settle the animal down. The *S* characteristically ceased all random movements and remained quite still on all four feet in the cage and did not change position appreciably during the rest of the trial. Nine more shots were fired at intervals of 23 sec. and the amount of startle was automatically recorded.

C. Results

The size of the startle response to the first experimental shot was measured and the mean magnitude for the various groups was as follows: operation group, .41 cm; operated control group, .41 cm; control group, .59 cm.

A Bartlett's test for homogeneity of variance was applied to these data. The Chi Square value was 1.09 and was not significant at the .05 level of confidence. An analysis of variance of the same scores indicated that the differences between the means of the three groups were not greater than might be expected by chance. $F = .51$.

D. Discussion

The results do not support the hypothesis that the magnitude of the startle response is a function of the level of endogenous adrenalin in the blood stream. Apparently neither endogenous nor exogenous (Moyer and Bunnell, in press-a) adrenalin contribute to the magnitude of the startle response. It is therefore unlikely that adrenalin is the physiological variable underlying the correlation between the base lymphocyte count and the magnitude of the startle response. The nature of this physiological variable is still a matter of conjecture.

E. Summary

Twenty-seven male, hooded littermate rats were used to study the effect of adrenal demedullation on the startle response. They were divided into three groups of nine *S*s each. Nine *S*s were subjected to a bilateral adrenal demedullation. Nine were given the same operation except that their adrenals were not disturbed, and nine served as non-operated controls. Fifteen days after the operation each *S* was placed in a stabilimeter-type of apparatus which recorded the magnitude of the startle reaction to the shot from a toy pistol. The results indicate that these are not significant differences between the startle responses of the three groups.

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A STUDY OF THE DEVELOPMENT OF THE NUMBER CONCEPT BY SCALOGRAM ANALYSIS*

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A. INTRODUCTION

Although the development of the number concept has been the subject of a considerable amount of experimental research,[2] it seems safe to state that relatively little progress has been made in our understanding of the nature of the developmental processes involved. There appear to be several reasons for this lack. On the one hand, most of the research has been of a normative, cross-sectional nature, and has usually limited itself to the study of one particular task, involving either mainly discriminative functions (e.g., Douglass, 1925; Judd, 1927) or rote counting and enumeration (e.g., Brownell, 1928; McLaughlin, 1935). Even in the more infrequent cases where investigators have compared the course of development for a number of different tasks (Descoeudres, 1946; Giltay, 1935; Long and Welch, 1941), these were selected in fairly unsystematic fashion, without any prior consideration of their possible theoretical significance. The main theoretical accounts, on the other hand, of the development of the number concept, such as that by Piaget (1952), have been lacking in adequate experimental support.

The present investigation represents an attempt to fill this gap. It starts from the theoretical premise that the development of a concept has its origin in an essentially discriminative function of abstraction, proceeding thence by a process of the gradual elaboration of mediating structures to an eventual state in which the concept exists as a purely representational symbolic entity.

This formulation corresponds essentially to the views of conceptual development advanced by Piaget (1950b) and Werner (1957); at the same time, it is consistent with behavioristic interpretations of symbolic functioning (cf. Munn, 1955; Nissen, 1951; Osgood, 1953).

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[2] For an annotated bibliography of this research, see Riess (1947).

It may be noted that the number concept is ideally suited for the verification of the developmental process postulated here, since it may be dealt with at widely varying levels of abstraction, ranging from the mere discrimination of the quantity of an aggregate of elements to the sophisticated, wholly symbolic conceptualizations of modern algebra. In the present study we shall limit ourselves, however, to but a portion of the total span of development in this area, starting from the point at which verbal mediators are just beginning to be formed, and ending with the first year of primary school. Beyond this point systematic instruction in the manipulation of number symbols presumably determines, to a large extent, the further development of this concept.

B. METHOD

1. *General Methodological Considerations*

The methodological approach adopted for this investigation was dictated by the developmental emphasis to be given to the problem, the basic question concerning the sequence through which an individual passes in the course of the development of the number concept. The normative, cross-sectional type of study, popular though it is in many phases of developmental psychology (including much of the research on the present topic), is of limited usefulness in this respect, since the mere determination of the average age at which a set of problems is solved by a sample of subjects provides us with no real picture of the extent to which the development of the abilities involved in these problems conforms to an orderly sequence. The longitudinal method is clearly more suitable in this respect, but has obvious disadvantages, mainly of a practical nature, in terms of time, expense, loss of subjects, etc.

A different kind of method, which provides essentially the same information about developmental sequences as the longitudinal approach, but which avoids the disadvantages of the latter, consists in an application of the technique of scalogram analysis. Let us consider a set of tasks calling forth behaviors which are thought to be acquired according to a sequential pattern. An analysis of the patterns of successes and failures on these tasks by individuals at varying developmental levels should then reveal whether these tasks constitute a scalable set. If they do, it may be concluded that mastery of a given task presupposes the mastery of all tasks which are below it in the hierarchy of difficulty, which is equivalent to the assertion of a sequential order of development of the functions tapped by these tasks.

Although the technique of scalogram analysis has been applied most frequently in the field of attitude measurement (cf. Guttman, 1950), at least one group of investigators (Schuessler and Strauss, 1950; Strauss and Schuessler, 1951) has employed it to study the genetic development of a particular concept—one which is in fact closely related to that of number—the concept of money. In view of the apparently sociogenic nature of this concept it is of considerable interest that these authors were able to construct scales of items involving various aspects of this concept which satisfied the usual criteria of reproducibility.

One defect of the study just cited is the rather arbitrary way in which items were selected for inclusion in the scales, so that the resulting scale types, although in some respects supporting notions of mental development advanced by Piaget and others, are of somewhat limited theoretical import. In the present study, the aim is to provide a sounder theoretical underpinning, by using the concept of levels of abstractness, or degrees of symbolic mediation, as a guiding principle in the selection of the individual tests. By utilizing, as much as possible, tests which on the basis of previous investigations may be assumed to vary on this dimension of abstractness, their relative places in the total sequence may be hypothesized on an a-priori basis. Thus the predictive value of this technique is considerably strengthened, in comparison with the approach, current in scalogram-analysis research, of selecting a set of items on a more or less intuitive basis, and rejecting those which turn out not to be scalable.

2. *Experimental Technique*

The basic technique employed in this investigation is the matching-from-sample technique. This method has shown itself useful in the study of conceptual responding at infra-human levels, as in the work by Harlow and his associates on monkeys, and at the Yerkes Laboratories on chimpanzees (cf. Harlow, 1951). It has also been applied specifically to the study of number discrimination in various species of birds (cf. Koehler, 1949). Although rarely used with children, the method appears to be promising with nursery-school *S*s, for a variety of reasons: the situation can easily be structured as a game for the child; the method readily permits systematic variation of the stimulus material without changing the nature of the tasks; furthermore, verbalization, both on the part of *E* and of *S*, is reduced to a minimum.

3. *Apparatus and General Procedure*

The apparatus consisted essentially of a wooden board covered with yellow cardboard and mounted on a base. Three rectangular apertures, 6 × 10 cm., were cut out of the center of this board, spaced in a horizontal row and separated by intervals of 6 cm. These "windows" were covered by masonite doors opening upwards towards the *S* and covered with white cardboard. Choice cards, 7 × 7 cm. in size, were hung over these doors. Behind each window a small flat cardboard box was affixed, serving as receptacles for small colored chips used as reinforcers.

The *S* was seated in front of the apparatus, so that his eyes were approximately on a level with the windows. For the initial practice trial, the following *choice cards* were hung over the windows: two blue dots arranged horizontally; three blue dots forming an isosceles triangle, and two purple concentric circles. The *sample card* for this preliminary trial, 10 cm^2, showed likewise two purple concentric circles (though somewhat larger than those on the third choice card); it was placed horizontally on the table just in front of the apparatus.

E told *S* that he wanted to play a game with him: *E* would hide a chip behind one of the windows and *S* was to try to find it. *E* further informed the *S* that he would be able to find the chip every time if he looked carefully at the (sample) card, for this card told him which was the right window. *E* then waited for *S* to choose and open one of the windows. If the choice was correct, *S* withdrew the chip from the receptacle and placed it in a little box in front of him. In the event of an incorrect choice, *S* was allowed to correct it, until he found the chip; he was urged to look very closely at the card on the table, since there was something on this card which told him which of the windows had the chip behind it. (This correction procedure applied *only* to this single practice trial.)

4. *Training Series*

Following the practice trial, the choice card with the concentric circles was replaced with one showing four dots in a diamond arrangement; the three choice cards thus represented the numbers two, three, and four, respectively, arranged from left to right on the windows. These stimuli, as well as those used in the test series, are illustrated in Figure 1, together with examples of the corresponding sample cards. The choice cards remained in place for the length of the training series (they were used in addition in several of the transfer tests that followed; cf. below). The training series further involved the use of a set of 18 sample cards, featuring 2, 3, or 4 dots in varying configurations, none of which were identical to any of the choice cards over the windows. As in the practice trial, the sample cards were placed, one at a time, on the table directly in front of

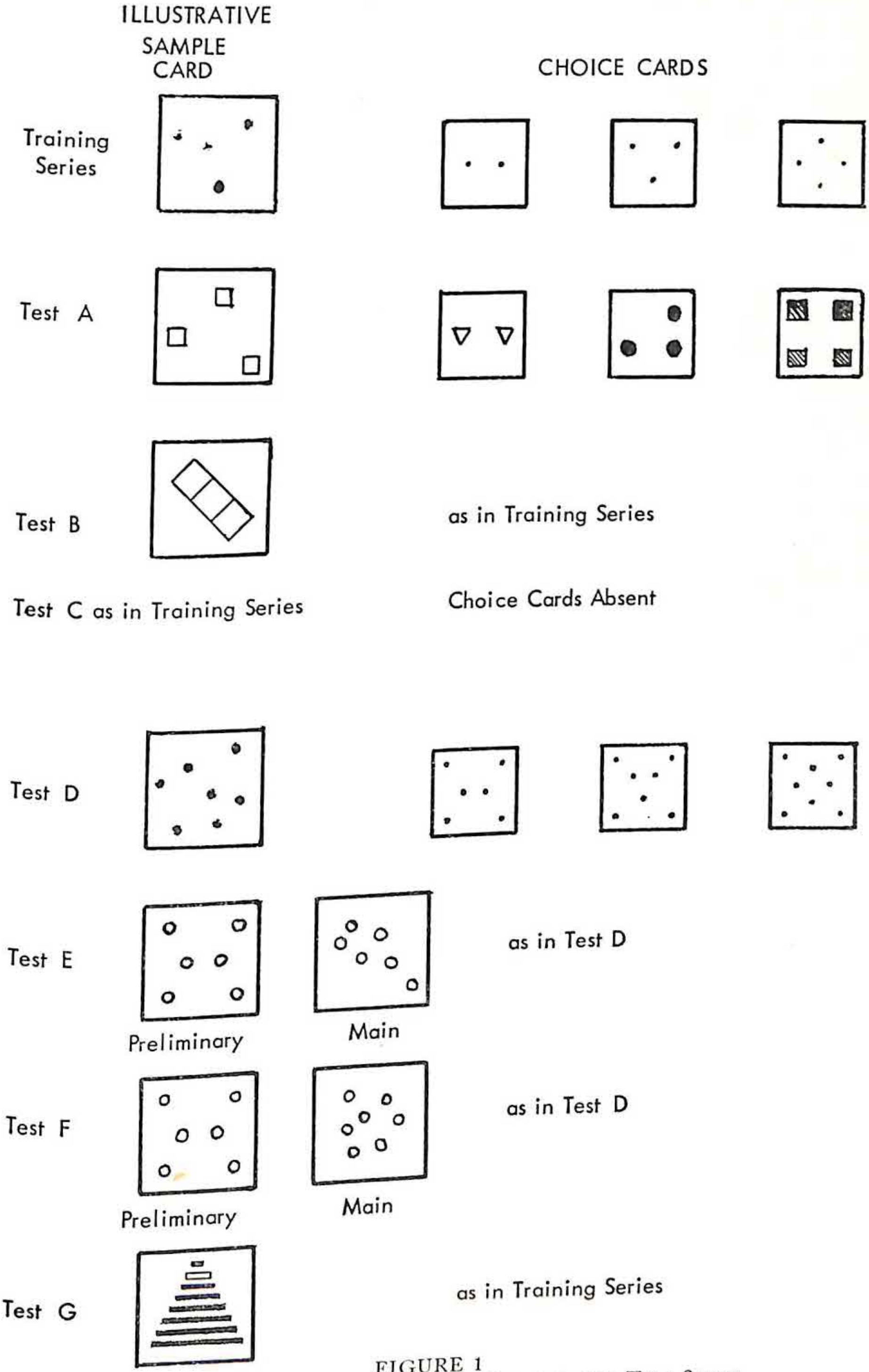

FIGURE 1
SAMPLE AND CHOICE CARDS USED IN TRAINING AND TEST SERIES

the apparatus. The *S* was not given the opportunity, however, to correct wrong choices. The criterion of learning was six consecutive correct responses; if this criterion was not met in 48 trials, the *S* was discarded from the study.

The training series thus elicited from the *S* a response based on the numerical correspondence between the dots on the sample and those on the correct stimulus card. In itself, however, this response need not be considered evidence for a conceptual response; it may represent rather a discriminative capacity of a fairly primitive order—as suggested by the success which Koehler and his associates (cf. Koehler, 1949) have had in training a variety of birds on number-matching tasks of this type. For our purposes, then, success on this learning phase was merely taken as an index of the lowest level of conceptual development in this area. At the same time this training series constituted a prerequisite for the subsequent transfer tests, in which *S*s were required to apply their number-matching set to problems of a more conceptual order. These transfer tests will now be described in their hypothesized order of difficulty, and their assumed significance as an index of conceptual development discussed.

5. *Test Series*

a. Abstraction. This test involved choice- and sample cards varying not only in number, but also in form (square, circle and triangle) and color (green, red, blue), in such a way that any given sample card matched each choice card on only one of the three dimensions. This test thus forces the *S* to abstract the dimension of number from among the other, irrelevant dimensions.

It should be noted that this task is still equivocal as regards the role of conceptual (i.e., symbolic) processes: as has been argued elsewhere (Wohlwill, 1957), abstraction, in the sense of a selective response to one aspect of a stimulus, is best regarded as a basically discriminative process. Nevertheless, particularly in view of the dominance of form and color over number in a multiple-cue matching situation with young children (cf. Descoeudres, 1914), it is clear that *S*s who had recourse to verbal mediators designating the number aspect of the stimuli would be at an advantage here, in the sense of being less likely to abandon their number set.

b. Elimination of perceptual cues. The choice cards for this test were those used in the training series (2, 3, and 4 blue dots). The sample cards contained rectangles drawn in outline and divided up into two, three, or four equal, adjacent squares, separated by thin black lines. These rectangles were arranged horizontally, vertically, or obliquely on the various sample cards.

This test differs from the training series in the presumed elimination of any conceivable perceptual cues (such as, e.g., total stimulus area, extent of figure-ground segregation) for the discrimination of the numerical correspondence between sample- and choice stimuli. A correct response requires, then, the intervention of symbolic processes (specifically counting) mediating this correspondence; accordingly one may hypothesize that this test will be somewhat above the previous one on the difficulty-hierarchy, and that *S*s succeeding on it will likewise solve the previous one.

c. Memory. For this test the sample cards were those of the training series, but the choice cards were removed, i.e., the windows were left blank. The *S* was thus called upon to make his choice by matching a given sample to the window which he had come to associate with the corresponding number.

Lest it be argued that the response here reflects simply a spatial association between the position of the windows and the corresponding number stimuli, it should be pointed out that there was no opportunity in the training series for such specific associations to develop, since the stimuli varied widely among themselves (i.e., in configuration) and generalized number-window associations would thus have required the mediation of schemata representing the individual numbers. Accordingly, a representational basis is assumed for the correct response in this test, leading to its postulated position following Test *B* in the present scale.

d. Extension. In this test the range of the number continuum was shifted upwards. Six, seven, and eight dots were shown on the choice cards, as well as, in varying configurations, on the sample cards. The test thus constituted an extension of the training series to this higher portion of the number scale.

The justification for placing this test above the previous ones is actually more empirical than rational. It has been shown, both on the infra-human level (Koehler, 1943) and in man (Kaufman, Lord, Reese and Volkmann, 1949; Taves, 1941), that immediate accurate discrimination of number breaks down above the number six. Thus, once again the intervention of the symbolic process of counting is necessary. It is known, moreover, that enumeration and the functional use of the number scale for numbers above five occurs considerably later than for the smaller numbers (Descoeudres, 1946; Giltay, 1935). Thus the reason for the hypothesized place of this test in the order of difficulty.

e. Conservation of number. For this test the choice-cards from the previous one, representing the numbers 6, 7, and 8, were retained. In place of the sample cards, a number of small buttons were employed, which at the start of each trial were arranged in a pattern exactly duplicating the configuration of dots on the corresponding choice card. *S* was told to look at the buttons, for there was one window which looked just like them; he then made his choice. Since the purpose of this preliminary choice was only to inform *S* of the choice card whose dots were in numerical correspondence with the set of buttons, *E* prevented *S* from carrying through an incorrect choice (by stopping him short if he moved to open a wrong window and asking him to try again, urging him to look carefully at the card). For the same reason these preliminary choices were not scored. Following this information portion of the trial, *E* scrambled the buttons by hand, in full view of *S*, calling his attention to *E*'s rearranging of the buttons. *S* then responded anew to one of the windows; for this choice, however, he was kept from counting the buttons (if necessary, by *E*'s covering them with his hand).

This test thus showed whether the *S* could respond in accordance with the principle of the conservation of number, i.e., whether he could maintain the numerical correspondence between the two sets of elements (presumably established for him in the preliminary part of the trial), in the face of a change in the visual arrangement of one set.

The inclusion of this test in the present series was prompted by Piaget's (1952) postulation of the conservation of number as a central step in the conceptualization process. It appeared worthwhile to attempt to verify this assertion in the behavioral terms of our testing procedure. It should be noted that this test differs from the previous ones in demanding a concept, not of an individual number, but of number-in-general, and more particularly of a functional property of this dimension: its independence of configurational aspects of the stimulus aggregate. One would not expect a concept of this superordinate nature to develop prior to the establishment of the subordinate concepts denoting the individual numbers; therefore this test is inserted at a level following Test *D* in the hypothesized developmental sequence.

f. Addition and subtraction. This test consisted of a set of trials similar to those of the previous test, with which they were interspersed (cf. below). The only difference between Tests *E* and *F* is that in the present test one button was either added to the collection in front of *S* or subtracted from it, immediately following *S*'s configurational match (i.e., just before *E* scrambled the set). In either case, *E* alerted *S* to the action which he was taking.

It was supposed that these trials would reflect an understanding of the relationship among adjacent numbers. This would again represent a superordinate aspect of the dimension of number. It goes beyond the concept of conservation, however, since the *S* was required to respond to the change in the numerosity of the buttons, through a symbolic operation of the type $x + 1 = y$. In addition, the *S* had to recognize the similar relationship among the choice cards. It seemed implausible that the *S* would be capable of responding to the change in number at this symbolic level, without having first developed an understanding of the characteristic of number as an attribute remaining invariant under configurational changes.

g. Ordinal-cardinal correspondence. For the purposes of this test, the choice cards of the original training series (denoting 2, 3, and 4) were employed, together with sample cards showing a set of eight solid bars arranged vertically in order of increasing length. The bars were all differently colored, one of them, in red, serving as the cue-bar. This bar was either in second, third, or fourth place in the series. *S* was told that he should look at the bars, and notice where he found the red bar among all the bars; this would tell him which window was correct.

This test was again suggested by Piaget's work on the number concept (Piaget, 1950a, 1952), in which the integration of the two aspects of number, ordinal and cardinal, is considered to be another focal point in the process of the conceptualization of number. Piaget (1950a, pp. 92-103; 1952, pp. 147-157) appears to regard the conservation of number as developmentally coordinate with the conceptualization of the relationship between ordinal and cardinal number, treating both as essential characteristics of the abstract, "operational" number concept. Nevertheless, it was our hypothesis that the present problem would follow the conservation test in the developmental sequence, on account of the assumed psychological difficulty for the child of bearing in mind simultaneously these quite disparate aspects of number, and the degree of symbolic elaboration of the number concept which appeared to be required for an integration of such abstract order.

The sequence in which these tests were given was the following: *C, A, B, G, D, E, F* (the last two were given in one joint series of 12 trials, six conservation trials being intermingled with three addition and three subtraction trials). This order was determined in part by practical considerations (such as giving all the tests involving 2, 3, and 4 before those involving 6, 7, and 8), and in part by the requirements of the tasks (thus *D* preceded *E* and *F*, in order to familiarize *S* with the new stimuli).

All tests normally consisted of six reinforced trials each, with the exception of Test *D*, which was presented for 12 trials, in order to provide adequate familiarization with the choice stimuli for the following conservation test. The criterion for passing was set at five correct responses out of six trials (10 out of 12 for Test *D*).[3]

6. *Supplementary Tests*

Two tests were added to the above set at the end of the experimental session. One was essentially a validation of the number-conservation test (*E*), through an adaptation of Piaget's (1952) procedure of direct interrogation. A row of six blocks was laid out in front of the child, and he was asked to place a set of buttons in front of them, so that there would be just as many buttons as blocks. (Mistakes on this part occurred very rarely; when they did, *E* corrected them.) After assuring himself of *S*'s perception of the equality of the two rows, *E* spread out the row of buttons in both directions to approximately twice the length of the row of blocks. *E* then asked *S*: "Now, are there more blocks than buttons, or are there more buttons than blocks, or are there still the same of both?" If *S* denied equality, the two rows were made to coincide again, the *S* reaffirmed their equality, and the above procedure was then repeated, but with the row of blocks now spread out.

In the other test, *S* was simply asked to count forwards to 10 and then, provided he did so correctly, to count backwards from 10. In this latter part, where *S* exhibited difficulty, *E* prodded him by asking: ". . . and what comes before 10? . . . and what's before nine?," etc.

The purpose of this second test was, on the one hand to determine the *S*'s rote-counting ability, and, on the other hand, to explore the relationship between the ability to reverse a series and the higher aspects of the development of the number concepts, as assessed in our tests *E*, *F*, and *G*. The importance attached by Piaget to the reversibility of operations in the development of conceptual thought generally (Piaget, 1950b), and the number concept in particular (Piaget, 1952), suggested the inclusion of this test, although it is important to bear in mind that the reversal of a verbal chain, such as the number sequence, is not altogether the same kind of phenomenon as the reversibility of mental operations, as it is discussed by Piaget.

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[3] On Tests *A*, *B*, *C*, and *G*, *S*s making five correct responses were given an additional three trials, with the purpose of setting up a more stringent criterion of eight correct out of nine trials. Since responses on these supplementary trials were, however, almost invariably correct, the uniform criterion of 5 correct was adopted. In addition, in the cases of Tests *C* and *G*, in order to permit later analysis of the results in terms of a more lenient criterion of seven out of nine correct, the three supplementary trials were given also to *S*s making only four correct responses in the first six trials. Due to the length of the experimental session, no supplementary trials were given on Tests *E* and *F*.

7. *Subjects*

A total of 77 *S*s were tested in this study. Of these five failed to reach the criterion of learning in the original training series within 48 trials. They were dropped from the study and will not be considered further. The remaining 72 *S*s are divided equally into six age levels, from 4:0 to 7:0, by half-year intervals. With respect to sex, the total group comprises 35 boys and 37 girls.

The *S*s were children enrolled in various kindergartens and primary schools in Geneva, Switzerland.[4] Almost all of them had been and were being exposed to informal and formal instruction in the area of number; for the most part such instruction followed the principles of the Montessori method, which emphasizes the development of the child's powers of observation, through tasks of discrimination or matching among numbers of objects, seriation of a set of objects by magnitude, etc. In addition, most of the children had learned to count; the first-grade children also had some instruction in the rudiments of arithmetic.

a. Experimental rapport. In general, the motivation of the children seemed quite high—the game aspect of the task apparently maintained their interest throughout the experimental session. In the case of a few of the youngest children, however, attention tended to lag visibly after ca. 20 minutes (the entire session ordinarily required 30 to 40 minutes). Whenever this became apparent, as was the case for six children, the session was stopped, and resumed on the following day; in these cases, the second session began with the administration of the training series to the original criterion, or with the repetition of the last transfer test passed by the *S*, and continued with the test following the last one completed at the first session.

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[4] The author gratefully acknowledges the generous cooperation of the Geneva Public Schools, and the following private institutions: École Ferrier, Jardin Joyeux and École Champod, in furnishing subjects for this investigation. In addition, the United Nations Nursery School provided valuable assistance in a pilot study from which the present investigation developed.

C. RESULTS

1. *Order of Difficulty*

Considering, first of all, the order of difficulty of the items of the scale, in terms of the number of *S*s (out of the total 72) passing each item, we find the following in Table 1.

TABLE 1
NUMBER OF *S*S PASSING EACH ITEM

B.	Elim. of percep. cues	49
A.	Abstraction	46
C.	Memory	32
F.	Addition and Subtraction	24
D.	Extension	21
E.	Conservation	14
G.	Ordinal-Cardinal Corresp.	6

The meaningfulness of these figures may be enhanced by referring to Table 2, in which the critical ratios associated with the difference between the proportion of *S*s passing each pair of items are listed.

TABLE 2
CRITICAL RATIOS OF DIFFERENCES BETWEEN PROPORTIONS OF *S*S PASSING EACH PAIR OF TESTS

Tests	G	E	D	F	C	A	B
G		2.31	3.44	3.84	4.60	6.03	6.41
E			1.94	2.67	3.40	5.49	5.75
D				0.83	2.12	5.00	5.29
F					1.51	4.31	4.64
C						2.99	3.40
A							1.00

An examination of these results discloses two main discrepancies from the hypothesized order: Test *B*, involving numerical correspondence without a perceptual basis was passed by a slightly, but non-significantly greater proportion of *S*s than Test *A*, which involved abstraction from irrelevant dimensions. The second discrepancy is rather more pronounced: Test *F* (matching of number after addition or subtraction of an element), instead of occupying a place above Test *E* (conservation), was very significantly easier than the latter, and even came before Test *D* (extension), though the difference between these two items was not significant.

Apart from these reversals, which will be examined more closely below in the discussion of the results for the individual tests, the results conformed to the hypothesized order. Differences between items predicted to be adjacent were significant at the .01 level for *B* vs. *E*, and at the .05 level for *C* vs. *D*, while for *D* vs. *E* the CR of 1.94 just misses the .05 level. In the case of comparisons between non-adjacent pairs, almost all are significant at the .01 level or better, whether we take the predicted or the actually observed order. For the latter, *C* vs. *D* is the only exception, with a CR of 2.12; in terms of the predicted order, the exceptions are *E* vs. *G* (2.31); *C* vs. *F* (1.51), and, as already mentioned, *D* vs. *F* (—0.83). For the test as a whole, furthermore, the rank-order correlation between predicted and observed order is .86.

The mere determination of the order of difficulty of these tests, however, does not in any sense touch on the central question with which we are concerned, viz.: is there a constant, predictable sequence in the order in which mastery of the skills involved in these tasks develops, such that success on any task presupposes success on all prior tasks? The answer to this question will be provided by the results from the scalogram analysis performed on these data, to which we shall now turn.

2. *Scalogram Analysis*

Guttman's original technique of scalogram analysis (cf. Guttman, 1950) has been the object of considerable criticism from a variety of sources (e.g., Green, 1954; Torgerson, 1958), due primarily to the lack of objectivity in the ordering of the observed patterns, and the very great dependency of the resultant coefficient of reproducibility on the marginal totals of successes and failures for each item. For the examination of our data, therefore, a more satisfactory analytic technique seemed indicated.

In their recent discussion of measures of reproducibility, White and Saltz (1957) present several alternative mathematical indices for determining the scalability of a set of items. Two of these which appeared to be particularly meaningful were selected for use in the present study. They are Green's index of consistency, based on his method of summary statistics (Green, 1956), and Loevinger's index of homogeneity (Loevinger, 1947). Both of these indices take into account the marginal totals of passes and fails for each item. Loevinger's technique has the advantage of utilizing all of the information in the data; that is, comparisons are made among all possible pairs of items to determine the relative incidence of error patterns (cases of + responses to the more difficult item coupled with — responses to the easier of the pair). Green's method, while examining only patterns for adjacent pairs or adjacent quadruplets of items, is somewhat less laborious, and allows, in addition, the calculation of an index of reproducibility equivalent to that devised by Guttman. Green's index of consistency, in fact, is simply the ratio of the difference between the observed and the expected (i.e., chance) reproducibility to the maximum value of this difference (i.e., for a perfectly scalable set of items).

Applied to the present data, the two indices actually turn out to be very closely comparable: Green's index of consistency, $I = .616$, and Loevinger's coefficient of homogeneity, $H_t = .620$.

Perhaps the meaning of these figures will become clearer if we consider Green's index of consistency, I. For our data, Rep_A (an estimate of the reproducibility of the responses from the scale types) $= .944$, and Rep_I (the reproducibility to be expected by chance, i.e., on the assumption of independence between responses to individual items) $= .855$, yielding

$$I = \frac{.944 - .855}{1 - .855} = .616.$$

These figures reflect the fact that with some items showing close to 100 per cent passes or fails (in our case this applies particularly to Test *G*, with 6 + and 66 —), chance reproducibility will be relatively high. The meaningfulness of even very high observed reproducibilities, such as found here, is accordingly reduced. This problem, which Guttman handles by recourse to a number of somewhat arbitrary and intuitive supplementary criteria for the evaluation of any index of reproducibility, is disposed of by the use of Green's index of consistency, which takes chance reproducibility into account. Following Green's suggestion (Green, 1956) of considering an I above .5 as indicating satisfactory scalability in a test, one may thus conclude that the present set of tests does in fact represent a single scalable dimension. At the same time the deviation of the observed I from its maximal value of 1.00 shows that the responses still fall considerably short of perfect consistency. Pointing to the same conclusion is the fact that only 45 of the 72 *S*s exhibited perfect scale-type patterns (i.e., patterns which could be reproduced simply from a knowledge of the number of tests they had passed). This proportion is further reduced to 29 out of 56, or barely over 50 per cent, if the *S*s passing or failing all of the tests—who would thus be perfectly fitted under any order of the tests—are left out of consideration.

It should be pointed out, furthermore, that our data fall short of meeting two requirements which are ordinarily considered to be essential in the application of scalogram analysis: our *N* is below 100, and the number of items is below 10.[5] As far as the number of items is concerned, Green (1956) actually points out that his index of consistency will be largely unaffected by this factor (in contrast to the index of reproducibility which is quite sensitive to changes in number of items). Since little is known concerning the sampling distribution of I, or of other measures of scalability, the effect of reduction in sample size is more uncertain. According to Willis (1954), however, the index of reproducibility is itself invariant for changing values of N, provided N is large in comparison with the number of scale types (the number of items plus one).

N will, of course, affect the SE of an observed reproducibility coefficient; for relatively small samples it is, therefore, important to guard against differences between observed and expected reproducibilities (Rep_A-Rep_I) which are merely due to sampling error. For this purpose the approximation of the SE of Rep_A proposed by Green (1956) may be used. In the present instance, this difference is found to be highly significant ($CR = 8.9$). This finding, then, in conjunction with the obtained value for I, suggests that we may with some confidence regard our set as representing a single, cumulative scale. The relevance of this scale to development is indicated, moreover, by its correlation with CA: $\text{Eta} = .52$. (Eta is to be preferred here over r both on logical grounds—the scale cannot be assumed to be an equal-interval one—and on empirical grounds, i.e., significant departure from linearity of regression.

One further problem which should be discussed in connection with the interpretation of the observed indices of scalability is that of the reliability of the responses to these items. As Green points out (1956), error in the context of scalogram analysis is apt to reflect lack of reliability rather than sampling fluctuation. Since our purpose was not one of test construction, it seems sufficient to note that lack of reliability would only be expected to depress the observed scalability of the items; thus, under more nearly ideal testing conditions a portion of the non-scale patterns might conceivably have been eliminated.

In this connection it is perhaps relevant to cite the results of a replication of the scalogram analysis (utilizing Green's method), employing more lenient criteria for passing on the more difficult tests (Tests C and G: 7 correct out of 9 trials; Tests E and F: 4 correct out of 6 trials; Test D: 9 correct out of 12 trials). Substantially similar indices of scalability are found for this analysis: $\text{Rep}_A = .931$; $I = .595$. (The order of difficulty of the tests remains unchanged.) Although the changed criteria result in a slightly larger number of error patterns—due presumably to decreased reliability—this increase in errors was nearly compensated by a decrease in Rep_{I} (chance reproducibility). This decrease from .855 to .829 seems to result from the somewhat less lopsided proportion of failures obtained on Test *G* with the more lenient criterion.

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[5] Practical considerations—particularly the limits imposed upon the length of the experimental session—precluded the addition of further tests to the scale.

3. *The Individual Tests*

In order to provide a somewhat fuller picture of the results obtained on the various tests, we shall now proceed to an examination of each of these in turn, with regard to their theoretical significance in the development of the number concept, as well as to such questions as discrepancies from the predicted order of difficulty and the kinds of errors commonly committed. In addition, the value of Loevinger's coefficient H_{it} (the homogeneity of an item with a scale) is given for each test. This coefficient indicates the extent to which the test scales with the set as a whole, in terms of its power to discriminate *S*s with a relatively higher total score from *S*s with a relatively lower total score.

a. Abstraction ($\text{H}_{\text{it}} = .913$). This test was predicted to be the easiest in the set, since considerable perceptual support was available for the number-match to be made; in fact this task was the only one which *S*s could, in principle, solve on a purely perceptual basis, without the intervention of mediating responses denoting the individual numbers. There were, however, only two *S*s who passed this test and no other, suggesting that under the conditions of our transfer situation few if any of the *S*s did respond successfully on this direct perceptual basis. The explanation appears to be that for those that were responding at a pre-conceptual level in the training series, the competing dimensions of color and form proved too potent distractors to allow them to maintain their number set. Evidence for this conclusion may be seen in the fact that of the 14 *S*s who failed on all items, all but one *S* made errors on at least five of the six trials of this test, indicating the virtual destruction of their original number-set due to the interference of the color and/or form cues. In contrast, the other 12 *S*s who failed this test but passed some other test, and who were thus presumably responding to some extent on a conceptual basis, made an average of 2.75 correct responses on this test. Under the circumstances, then, the emergence of this test as second in order of difficulty, essentially at the level of Test *B*, is understandable.

It may be noted in passing that of the two competing dimensions, color proved much the more popular as a basis for the children's error responses, accounting for 78 out of a total of 114 errors, or 68 per cent. This finding is in line with the frequently observed dominance of color over form in children of nursery-school age (cf. Brian and Goodenough, 1929; Lindberg, 1938).

This test of abstraction may be considered, then, as an expression of the child's response to number on a conceptual level, albeit in a most elementary sense. Although no direct evidence is available on this point, it presumably reflects the child's ability to verbalize the numbers (implicitly or overtly), thereby making the response more resistant to interference from the irrelevant cues.

b. Elimination of perceptual cues ($H_{it} = .891$). This test, as noted previously, was passed by the largest number of *S*s. There is, nevertheless, little reason to doubt the validity of the interpretation originally given this task as involving a symbolically mediated response. Thus it was frequently observed that *S*s passing this test counted the squares with their fingers (although the more advanced children did not need to do this overtly). Furthermore, there was again, on this test as there had been in Test *A*, a fairly sharp differentiation between the performance of *S*s who failed all tests and those who passed some other test. The 14 *S*s of the former group made an average of only 2.1 correct responses, as against 3.3 for the 9 *S*s of the latter group. This difference is significant below the .05 level ($t = 2.62$, for 21 *df*). (The fact that the first figure, 2.1, is somewhat higher than the corresponding one in Test *A* need not surprise: in the present test there are no obvious alternative cues on which *S* might consistently base his response; on a random basis one would, therefore, actually expect two correct in six trials on this three-choice problem.)

c. Memory ($H_{it} = .524$). This test followed Tests *A* and *B* in order of difficulty, as predicted. Indeed, it was rather sharply differentiated from the latter, in the sense that the gap between Tests *C* and *D* was the largest of any gap between adjacent tests (in terms of the number of *S*s passing each). At the same time, there was an an appreciable gap (of eight *S*s) between it and Test *F* which ranked immediately above it. This result appears to support the conception of this task as one which involves a conceptual response to the individual numbers, requiring, however, a considerably greater stability or strength on the part of the mediating structures than is the case for Tests *A* and *B*. The absence of the choice cards, and the consequent need to retain them in memory is presumably responsible for this difference, in somewhat similar fashion as in the case of delayed reaction tests (cf. Munn, 1955, pp. 138 ff; also Harlow, 1951, pp. 224 ff).

Nevertheless, in spite of the seemingly well-determined rank of this test, it proved to be one of the least satisfactory, in terms of its homogeneity with the scale as a whole, as seen in the low value for H_{it}. This figure reflects the fact that a considerable number of *S*s passed tests which ranked above Test *C*, but failed on this test. Undoubtedly the memory element of the task contributed to this lack of consistency in the responses on this test: some *S*s evidently had forgotten which window represented which number, as shown in their correct verbalization of the number on the stimulus card preceding their incorrect choices. In this connection, it must be realized that many of the *S*s started with a criterion run on the training series, so that they had only six trials to familiarize themselves with the choice cards; thus their failure to remember their positions is not too surprising. It is possible that this test would have been more meaningful if it had come later in the series, so that the *S*s' associations of the numbers to the windows might have become stabilized.

d. Extension ($H_{it} = .874$). This test placed after, rather than before Test *F*, but ahead of Test *E*. Considering the strong dependence of performance on this test on specific learning (i.e., counting), and the associated fact that frequently failures were caused by mistakes in the counting of the dots on the stimulus or choice cards, the homogeneity of this test with the scale is rather high. It seems, then, that differential responding for this part of the number dimension does constitute a conceptual process of a higher order than the previous problems, which involved only the lower numbers. It is plausible to attribute this increased difficulty to the very fact that the number concepts in question no longer benefit from direct perceptual support, thus necessitating the intervention of the symbolic activity of counting.

e. Conservation ($H_{it} = .842$). As anticipated, this test was one of the most advanced of the scale; it placed only below Test *G* in order of difficulty. Its place in the sequence was fairly well determined: the gaps between this and the adjacent tests below and above it, in terms of numbers of *S*s passing, were seven and eight respectively (the corresponding CR's are 1.94 and 2.31). Furthermore the frequency-distribution of correct responses on this test was markedly *U*-shaped, with a mode at 0 (Table 3).

Such a distribution suggests something aproaching an all or none character for the comprehension of the concept which this test entails.

These findings lend some support, then, to the importance which Piaget (1952) attaches to the attainment of conservation as a step in the development of the number concept, as well as that of other concepts. In this

TABLE 3
FREQUENCY-DISTRIBUTION FOR CONSERVATION-RESPONSES ON TEST E

Number correct	f
0	23
1	17
2	10
3	4
4	4
5	7
6	7

connection, it may be noted that there was a substantial degree of correspondence between the responses to this test and those made on the verbal form of the conservation problem: of 13 *S*s who passed the conservation test, 11 admitted the conservation of number in direct questioning, while there were only 10 such *S*s among the 58 who failed the test. (In explanation for these latter cases, it can be argued that our problem involves the *application* of the conservation principle to a concrete situation, as opposed to the verbal form, where it is more a question of the *recognition* of this principle.)

An examination of the relationship between performance on the present test and Test *F* (addition and subtraction) affords perhaps a somewhat clearer picture of the developmental process involved in the achievement of conservation. It will be remembered that the addition and subtraction trials were postulated to be of greater difficulty than the conservation trials, since they involve a grasp of the relationships among the numbers which did not apear to be essential to the manifestation of conservation. In point of fact, as we have seen, the reverse held true: Test *F* was substantially easier than Test *E*; indeed, there were 12 *S*s who passed *F* and failed *E*, whereas only two *S*s reversed this order (both of these *S*s actually made four correct responses on the six trials of Test *F*, thus barely failing to attain the criterion for passing).

It is nevertheless of interest that there were six *S*s, among the 12 passing *F* and failing *E*, who gave definite evidence of conservation, although "officially" failing the test. These were *S*s who responded incorrectly on the first two or three conservation trials, but showed "learning" in the latter part of the series, as they made correct responses on the last three or four conservation trials. (As the frequency distribution above shows, these six *S*s accounted for all but two of the *S*s with three of four responses on Test *E*; the other two failed Item *F*, but one of these had four correct on this latter test.) The implication of these findings is that the addition and subtraction trials, which were interspersed with the conservation trials, had the effect of suggesting to the *S*s the conservation of the number aggregate in the conservation trials, where no element was either added or subtracted but only the perceptual configuration was changed. If this interpretation is correct, it would be clearly relevant to the understanding of the way in which this concept of conservation emerges, i.e., through a prior conceptualization of the operations of addition and subtraction, at least in their rudimentary forms. This view suggests the possibility of establishing the notion of conservation through repeated exposure to the effects of addition and subtraction.[6]

Finally, an incidental finding which emerges from the errors made on this test is a bias in the direction of a perceived increase in number with a change in configuration. Thus of the 101 errors made on No. 7, 64 were choices of 8, as against 37 choices of 6. A similar effect was seen in the errors made on the addition and subtraction trials of Test *F*: on addition trials involving $6 + 1$, 8 was chosen 55 times, whereas on subtraction trials involving $8 - 1$, 6 was only chosen 10 times. In view of the fact that the configurational changes effected by *E* in moving the buttons tended to decrease the separation between the buttons, on the average, one admittedly ad hoc explanation for this finding would be that *S*s are more apt to respond in terms of the density of the elements in the configuration than in terms of its area.

f. Addition and subtraction ($H_{it} = .777$). The results for this test do not require extended discussion. The main finding, that its place in the hierarchy was ahead of Test *D*, instead of following Test *E*, has been discussed already in the previous sections.

We have noted that success on the addition and subtraction trials appeared to be virtually a prerequisite for the manifestation of conservation. Furthermore, there were eight *S*s who passed this test but failed Test *D*; thus it appears that on the lowest level success on this test was based less on a precise realization of the arithmetical relationships involved, (e.g., $6 + 1 = 7$) than on a possibly still rather intuitive perception of the order among the choice cards, and of the effects of addition and subtraction. This interpretation would account also for the somewhat low homogeneity of this item with the total scale.

That passing this test nevertheless reflects something over and above a symbolically mediated response to individual numbers is indicated by the very clear-cut separation between this test and the two lowest (*A* and *B*): there were only two *S*s who passed the present test while failing either of the other two.

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[6] Some pilot work along these lines by the author indicates modest success for this approach, depending on the level of development of the *S* at the time the learning takes place. More extensive investigation of this problem is contemplated.

g. Ordinal-cardinal correspondence ($H_{it} = .480$). As predicted, this test was the most difficult of the set; indeed, only six *S*s achieved the criterion for passing (five correct responses in six trials). There is, however, some doubt whether the conceptualization of the relationship between ordinal and cardinal number is all that is reflected in performance on this test. It could be argued that success here clearly presupposes the selection of an appropriate hypothesis relating the ordinal position of the cue-line to the number to be chosen. It is thus perhaps unrealistic to expect *S*s generally to show an immediate transfer of their previously developed number set to this problem. The fact that six additional *S*s with four correct responses in the first six trials proceeded to respond correctly in the following additional trials which they were given (cf. Footnote 3 above) strengthens this argument.

Under these circumstances the low homogeneity of this item is not too surprising. It should be realized that the value of H_{it} here is partly a function of the lopsided distribution of passes and failures, i.e.: the more this distribution diverges from 50-50, the less tolerance for error is available.

One way of improving the meaningfulness of this test may be suggested: preceding the ordinal-cardinal series, the *S*s' attention could be directed to the ordinal aspect by having choice cards which themselves showed the cue-line in differing ordinal positions; this would then be a problem of simple ordinal correspondence. In this way the *S* would presumably be set to respond to the ordinal-cardinal correspondence in the main problem, if he is able to conceptualize this relationship. Exploratory work with this procedure indicates, in effect, that this test is essentially comparable in difficulty to the conservation test.

Finally, one particular mode of responding on this test is worth singling out: There were a number of *S*s who, on the basis of their counting of the lines on the sample cards, and in some cases of their verbal explanations at the end of the test, gave evidence of matching the (cardinal) number of lines *up to, but not including* the cue-line to the number of dots on the choice cards. This type of error was already noted by Piaget (1952, pp. 111 ff) as marking a phase antecedent to the integration of the ordinal and the cardinal aspects of number, which requires the identification of the position of an element with the cardinal number of the set of elements which has that position as its boundary.

h. Supplementary test: Counting forwards and backwards. The results with respect to the *S*s rote-counting ability, tested at the end of the experimental session, deserve brief mention. Due to their direct dependence on training experience and practice, they were not included in the main scale of number development, nor expected to show very great consistency in relation to the tests of the scale. This turned out to be the case, particularly for counting forwards (to 10), which all but nine *S*s were able to do. Thus this ability by and large preceded the conceptual behaviors demanded by even the lowest-level tests, as shown for instance in the fact that 10 of the 14 *S*s who failed all tests counted to 10 without error.

Backward counting, as found previously by McLaughlin (1935), proved to develop substantially later. Even with the help often provided by *E* (cf. section on methodology above), only 24 *S*s gave perfect responses (nine others made one or two mistakes). A general picture of the relationship between this skill and performance on the main tests is given by the following comparison: of the *S*s with from four to seven passes on the tests, 16 out of 26 counted backwards without error; of the *S*s with from zero to three passes, 8 out of 46 did likewise. This relationship, though clearly significant ($\chi^2 = 12.65$, $p. < .001$), is hardly closer than would be expected for any two functions developing roughly together in time. The relationship with individual tests of the scale is generally consistent with this overall association.

D. DISCUSSION AND CONCLUSIONS

1. *Three Stages in the Development of the Number Concept*

The foregoing discussion of the tests taken individually should not leave the impression that each of these tests represents, in fact, a discrete, well-determined point on the scale of conceptual development. The lack of significant separation between various pairs of adjacent tests, as well as the low homogeneity of some of the tests show that such an interpretation is not warranted by the data.

It seems possible, however, to use these results as evidence for the existence of three fairly sharply differentiated stages in the development of the number concept. The dividing points between these stages may be defined by the two most popular response patterns: uniform failures on all tests (14 *S*s), and passes on Tests *A*, *B*, and *C*, with failures on the other four tests (8 *S*s). If we eliminate, furthermore, Test *E* from the first group (a procedure which, though ad hoc, is not entirely unjustified, in view of the ambiguity of the meaning of failure on this test pointed out above), the distinction between these stages emerges most clearly: the 29 *S*s who failed either

Test *A* or *B* (or both) accounted for a grand total of only five passes on all of the tests of the second set combined.

The significance of this breakdown of the results is apparent from an examination of the nature of the tests concerned: *A* through *C* involves the matching of particular numbers, under conditions of varying amounts of perceptual support for such matching; Tests *E* through *G*, on the other hand, invoke higher-order relationships among numbers, representing functional characteristics of the number continuum (as for Test *D*, which would seem to fit more closely into the first group, it demands, as noted previously, the ability to enumerate which in itself may be suggested as a prerequisite for a mastery of the functional relationships among the numbers).

We may thus describe the process of concept formation in the domain of the number concept in terms of the following three stages: an initial, pre-conceptual one, in which number is responded to purely in perceptual terms, without any symbolic mediation; an intermediary one, in which the mediating structures representing individual stimuli on this dimension are developed, so that the perceptual support necessary for generalization between two equivalent stimuli on this dimension is steadily reduced; a final one, in which superordinate structures representing the number concept in the abstract, and relating the individual numbers to each other are elaborated, thereby leading to an understanding of such functional principles as the conservation of number and the coordination between ordinal and cardinal number.

This is of course only one among a variety of possible ways in which one may conceptualize the nature of the development of the number concept. Piaget (1950b, pp. 123-155) has described the developmental process in somewhat different, though clearly related terms, proceeding from a stage of pre-conceptual thought through a stage of intuitive thought to the eventual formation of "concrete operations," characterized by conservation and reversibility. This formulation has the advantage of being applicable more generally across several different areas of concept formation; at the same time it covers a rather more restricted range of functions within any given area such as number.

Yet another view of development with respect to the concept of number is presented in the recent work of Gast (1957). This investigator is essentially concerned with the degree of perceptual and functional heterogeneity of the stimulus materials which the child can tolerate in admitting a collection of objects as representing a single cardinal set, for purposes of enumeration, number-matching, etc. He finds an initial stage in which virtually complete homogeneity of the elements is required; a second in which perceptual diversity is possible, within certain limits of qualitative resemblance among the elements, and a final one in which the objects may belong to several disjunctive and altogether disparate classes.

In spite of the differences in emphasis of these various analyses of the developmental process in the formation of the number concept, they doubtless involve, if not the same, at least closely related psychological processes developing in parallel. It should thus be possible to formulate a developmental theory sufficiently general to encompass these various aspects of conceptual development, while still being specific enough to afford predictive power and to relate it directly to the content of particular problem situations.

In any event, the results of our study confirm both the findings of Gast and the theoretical views of Piaget, in demonstrating the existence of a relatively uniform developmental sequence in the area of the number concept. To that extent they contradict the results obtained by Estes (1956), who attempted to differentiate between 4-, 5-, and 6-year old children on the basis of a series of tests suggested by Piaget's work, notably that concerned with the concept of conservation. Estes found no consistent differences between her age groups on these tests. But in view of the cross-sectional method employed, the relatively small number of *S*s tested (in the face of the well-known individual variation in rate of development) and the apparently inadequate methodology employed, these results can hardly be taken as conflicting evidence with respect to the reality of developmental stages in this area. Certainly our results belie the rather sweeping conclusion which has been made by at least one author on the basis of Estes' study, to the effect that "the 'developmental stage' approach to child behavior continues to suffer critical damage by being subjected to careful empirical test" (Sears, 1958, p. 135).

2. *The Determination of Developmental Sequences through Scalogram Analysis*

Since we have in this study employed the technique of scalogram analysis to trace developmental processes, the basic premise of this approach, that scalability of responses to a set of problems is evidence for a single developmental continuum, should be discussed in somewhat more explicit terms.

It is a unique feature of scalogram analysis—as of latent structure analysis, of which the former is but a special case, cf. Torgerson, 1958—that it scales *both* stimuli (i.e., the items) and subjects simultaneously, on the basis of the same criterion: the response patterns observed. This feature is clearly a double-edged sword: it presents a clear advantage, in so far as it obviates the necessity for an independent measurement device for scaling the items; on the other hand, it places very definite limitations on the logically justifiable interpretations that can be made on the basis of a determination of scalability in a given set of items.

This latter problem does not typically arise in such traditional fields of application of scalogram analysis as that of attitude studies. There the question is usually merely whether a judiciously—and often rather arbitrarily—selected set of items represents a single unidimensional continuum for purposes of measurement, so as to allow one to rank the subjects on this dimension on the basis of their responses to the items.

What we have done in the present investigation, however, goes considerably beyond the determination of an ordinal scale of measurement. In effect, we have inferred, on the basis of the demonstrated scalability of our tests, the operation of a single developmental process, running in the direction of increased symbolic mediation. Such an inference clearly demands two supplementary steps: first, an independent validation, on internal grounds, of the psychological dimension defined by the items, and second, the identification of the ranking of the *S*s on this scale with psychological development.

As regards the first point, it may be noted that it would be a matter of ease, for a group of *S*s varying in age, to construct a perfectly scalable set of items which would nevertheless fail to represent any specifiable psychological dimension (for instance: ability to walk; achievement of bladder control; ability to define "orange"; ability to drive a car). It is thus apparent that the attribution of a psychologically meaningful developmental process underlying performance on the tests of our scale has to be grounded in the content of the component tests. This consideration argues for the advisability of employing items whose psychological significance is at least to some extent understood, and, more important, to utilize this knowledge in order to formulate an a-priori hypothesis concerning the assumed ordering of the items.

In the present study we have attempted to conform to these desiderata by choosing tests for which it was at least possible, on logical and empirical grounds, to advance a hypothetical order of difficulty. The close correspondence found between our hypothesized order and that actually found would seem to confirm the meaning attributed to the developmental sequence which emerged from the patterns of responses.

As for the second point, the interpretation of the scale in terms of a *developmental* sequence is predicated on two assumptions. The first is that with increasing age a change in the direction of a higher scale type would in fact take place. Short of a longitudinal follow-up, this assertion can be verified only by a determination of a substantial correlation between some independent criterion of development (e.g., CA) and the scale type (total score) attained on this set of problems. In our case the correlation between CA and scale type is .52. This correlation is probably as high as should be expected, given the extent of variability in rate of growth in a heterogeneous population; at any rate it appears adequate to justify the equation of our scale with a developmental sequence.[7] The additional assumption which has to be made is that a given subject, if tested at a prior or later point in time, would still respond in conformance with the scale (i.e., only his scale type would be changed, but except for incidental "error" patterns no new response patterns would be found). The validity of this assumption rests on the adequacy of the sampling: it is presumed that a sufficient number of subjects at all stages of development have been tested to disclose the major response patterns that are to be expected at the different levels of the scale.

3. *The Origin of the Developmental Sequence*

Of somewhat broader significance is the question of the origin and determinants of a developmental sequence such as the one we have observed. Regularity and consistency in the order of appearance of specific behavior patterns has been used as one criterion for the maturational origin of such behaviors, notably in the area of motor development (cf. Ames, 1937; Shirley, 1931). For a variety of reasons, however, such an inference would not be warranted in the present instance. Not only is the environment of the *S*s represented in our sample much too homogeneous, but, more fundamentally, the very nature of this particular developmental sequence precludes the possibility of regarding it as a purely maturational phenomenon, dependent as it is on the formation of mediating symbols which, it would seem, can only be cultural in origin.

Yet, granted that environmental influences can scarcely be ignored as factors in the development of the responses represented in our tests, the actual mechanisms accounting for this sequence still remain to be explained. The main question is whether the changes involved in a child's progression along this sequence represent the product of specific learning due to practice, or whether more generalized experiential effects are at work here.

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[7] It might be thought that mental age would provide a better test of validity here. However, apart from the fact that information regarding mental age was not available for these children, none of the intelligence tests presently in use appear to have sufficient "construct validity" (cf. Cronbach and Meehl, 1955) to be of much value in the assessment of the developmental level attained by a child. As a matter of fact, in the study of the development of concepts of money by Schuessler and Strauss (1950), referred to in the introduction to this article, it was found that partial correlations of scale type with CA were substantially above those with MA.

In the absence of precise knowledge concerning and control over the previous experience of these children, it is obviously not possible to answer this question directly. Let us examine, however, the role of two specific factors that might be suggested in this connection: those of language and of pedagogical experiences.

With respect to the language factor, one may ask whether progression along our sequence does not merely reflect the mastery of the verbal labels representing the number scale. Several lines of evidence allow us, however, to dismiss this linguistic factor. First of all, the large majority of the children—including 10 of the 14 who failed all tests—could count up to 10 by rote (there were nine *S*s who could not, but seven of these children counted at least up to four, without any effect on their ability to solve those problems involving the lower numbers). Secondly, if this factor were chiefly responsible, all tests involving numbers 2, 3, and 4 on the one hand, and numbers 6, 7, and 8 on the other hand, should be mastered simultaneously, but, as our scale shows, this was by no means the case (cf. the significant differences between such pairs of tests as *C* vs. *A*, *C* vs. *B*, *E* vs. *F*, *G* vs. *A*, *B*, and *C*, Table 2).

In connection with this point regarding the role of language, a different study by the author may also be cited (Wohlwill, 1960). This study showed that the mere availability of verbal labels to designate the number of a visual aggregate is of very little significance in a subject's performance on a learning task which demands a consistent response to a particular absolute number. Even if this result may be attributable in part to the perceptual nature of the task, it illustrates the fallacy of interpreting cognitive performance in terms of verbal habits. The same conclusion appears to be indicated by Martin's (1953) finding that a test of children's spontaneous use of quantitative vocabulary in the description of pictures failed to correlate significantly with a more conceptual test of number ability.

The second factor, that of pedagogical influences, is more difficult to evaluate. It is true that most of these children were in fact exposed to a relatively uniform set of pedagogical experiences, including exercise and instruction in the elementary aspects of number, from the kindergarten period onwards. This kind of experience undoubtedly affected the performance of the children on these tasks to some extent. Nevertheless, the tasks had for the most part rather little in common with the practice in rote counting, naming and discrimination of number which constituted the bulk of the scholastic training which the children had received. This is true particularly for our Tests *A* (abstraction); *C* (memory); *E* (conservation), and *G* (ordinal-cardinal correspondence). Thus it does not seem too plausible to argue that the observed order of mastery of our tests was a direct function of the specific training which the subjects were exposed to in school. The fact that grade in school (i.e., nursery-school level, kindergarten, or first grade) was only very imperfectly related to performance on our tests further weakens this argument.

Having discarded, then, the influence of specific practice due to commonly shared learning experiences on our developmental sequence, one may still attribute it to cumulative learning effects of a relatively non-specific type, such as illustrated in Harlow's (1949) work on learning sets. Alternatively, one might postulate organismic changes of a strictly maturational kind, determining the child's ability to assimilate and make use of his previous experiences and learnings for the solution of the tasks in our test series. But, as for most psychological problems, a sharp differentiation between maturational and experiential factors hardly seems very fruitful here. The real question may be stated perhaps more appropriately in terms of the extent and breadth of the generalization and transfer of particular learned behaviors which are possible at different levels of development. For instance, although the point has not been demonstrated experimentally, it seems most likely that the number of problems necessary for the formation of a discrimination learning set would decrease steadily with increased age (indeed, this does appear to be the case for phylogenetic development; cf. Miles, 1957). In other words, very general experience, assimilated and transformed in the course of development, can to a large extent replace more specific practice as a condition for learning. Applied to our study, this interpretation would attribute the change underlying a child's progress from the first to the second, or from the second to the third phase, not in terms of practice in counting, or experience with the conservation of number, but rather in terms of cumulative experience in the discrimination and identification of number, and in the abstraction of invariant properties from changing stimulus complexes.

The central problem, in any event, appears to be the following: responses to numerical correspondence, above the simplest level, are clearly based on mechanisms of mediated generalization, i.e., on the intervention of internalized symbols representing the numbers. Although such mediating mechanisms have been invoked in the explanation of developmental differences in discrimination learning and transfer (e.g., Alberts and Ehrenfreund, 1951; Shepard and Schaeffer, 1956), and have, in fact, become a central construct in Osgood's (1953) attempt to extend traditional S-R association theory to the area of concept formation, little work has been done thus far on the actual formation of these mediating responses (thus, most of the so-called concept formation literature utilizes concepts which are already in the *S*'s repertoire). Our study can perhaps contribute to this problem by showing the gradual emergence and stabilization of these mediating structures during the course of development; more particularly, it follows this process to the further formation of structures of a superordinate kind, which, in the case of the number concept, form the basis for a truly abstract representation of the dimension of number. Thus this study points the way to the investigation of a problem not heretofore tackled by behavioristic theorists, that of the conceptualization of the relationships among objects, rather than of the objects themselves. Indeed, one might argue that a true concept of an object requires the former, i.e., inevitably involves the formation of superordinate structures relating the object to others which are not instances of the class.

The specification of the developmental sequence is, however, at best a first, descriptive, step in the analysis of the processes involved in concept formation. In future investigation of these problems, an approach appears to be indicated which focuses on the effects of different types of experience, perceptual and linguistic, specific and generalized, on the development of particular aspects of the number concept, and on the differential effects of such experience at different developmental levels. Through such an aproach one may hope eventually to gain some insight into the nature of the changes taking place as the child progresses along the developmental scale and achieves an increasingly elaborate and abstract concept of number.

E. Summary

This investigation concerns itself with the developmental process by which the young child arrives at an abstract concept of number. This process was traced through the construction of a series of problems presumed to demand a conceptual response to the dimension of number at progressively more elaborate levels of symbolic mediation, the aim being to determine the extent to which mastery of these problems conforms to an ordered developmental sequence.

A matching-from-sample technique was employed in which the *S* is presented with a stimulus card designating a particular number and required to choose from among the choice stimuli the one depicting the same number as the sample. The main series of problems was prefaced by a training series in which both sample and choice cards contain 2, 3, and 4 dots in varying configurations; this series was designed to establish in the *S* a set to respond to the number dimension. The following test series then showed the *S*'s ability to transfer this response to problems in which the correspondence between sample and choice stimuli requires symbolic mediation in a varitey of ways and extents.

The problems of this transfer series, in the hypothesized order of difficulty, entailed the ability, (*a*) to abstract number from among simultaneously varying irrelevant cues; (*b*) to match sample and choice cards in the absence of a perceptual basis for the numerical correspondence between them; (*c*) to match the number of the sample to the position of the corresponding choice stimulus, when the latter is removed from view; (*d*) to extend the number-matching response to larger numbers of dots (6, 7, and 8); (*e*) to respond in accordance with the principle of the conservation of number (i.e., the invariance of the number of an aggregate under configurational changes in the patterning of the elements); (*f*) to take into account the change in the number of an aggregate produced by the addition or subtraction of an element; (*g*) to match the ordinal position of an element in a series to the corresponding cardinal number.

Each test consisted of six trials, the criterion for passing being five correct responses. (On Test *D* 12 trials were given, and the criterion was 10 correct.) Seventy-two *S*s were tested, ranging in age from 4:0 to 7:0, with six *S*s at every half-year interval.

The chief analytic technique for the evaluation of the data was that of scalogram analysis. An application of Green's (1956) method of summary statistics yielded a coefficient of reproducibility of .94. The value of the associated index of consistency (which evaluates the observed reproducibility in terms of that to be expected by chance) was .62. These figures indicate that there was a very substantial degree of order in the response patterns of the individual *S*s, such that the mastery of any given item presupposed, in general, success on all easier items. Such a finding justifies the postulation of a single scale of conceptual complexity underlying these problems and suggests the operation of a consistent developmental process in the conceptualization of number.

The observed order of difficulty corresponded very closely to the predicted one, the major discrepancy relating to Test *F*, which placed somewhat ahead of Test *D*, instead of following Test *E*. Various aspects of the results caution one however against regarding these tests as representing a series of fixed and equally disctinctive steps on the developmental scale. Instead, the developmental process is more adequately described in terms of three fairly discrete phases: an initial one in which number is responded to wholly on a perceptual basis (none of the transfer tests are passed); an intermediary one in which individual numbers are responded to in conceptual terms (passing of Tests *A*, *B*, and *C*); a final phase in which the *relationship* among the individual numbers is conceptualized (passing of all tests, with the frequent exception of *G*). In the progression from the first to the intermediate level, the mastery of verbal labels designating the numbers plays a prominent role. The learning of the number series likewise appears to play some part in the transition to the third phase, but in addition the conceptualization of number as a superordinate-level concept enters as an essential requirement.

The relevance and limitations of scalogram data in the determination of developmental sequences are examined in the light of this study. A final discussion focuses on the question of the origin and determinants of the observed developmental sequence, and particularly on the roles of specific learning and generalized experience in concept development. The study of the interaction of these factors suggests itself as a possibly fruitful approach to the fuller understanding of the transitional processes involved in this development.

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A TEST OF THE CRITICAL PERIOD HYPOTHESIS AND A FURTHER STUDY OF THE RELATIONSHIP BETWEEN AGE AND CONDITIONING IN THE C57BL/10 MOUSE*

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A. PROBLEM

In a previous paper investigating the effects of age and early experience upon conditioning in mice, Denenberg (1) studied *S*s between the ages of 13 and 150 days. Thirteen-day-old mice could not be conditioned using a buzzer-shock technique. The function rose sharply to a peak at 20 days and then generally declined with other peaks at 35 and 100 days of age. *S*s which had initially been tested at 16, 20, 25, 30, 35, or 40 days were presented with the buzzer alone at 50 days until they met an extinction criterion and were then given 10 additional paired buzzer-shock trials. The extinction data were a positively accelerated function of initial test age with *S*s tested at 16 days making no responses to the buzzer while the mice tested at 40 days took longest to meet the criterion. However, on the subsequent conditioning trials it was found that the *S*s initially tested between 20 and 40 days of age all had essentially the same conditioning score and were significantly better than controls, while the mice tested at 16 days did not differ significantly from the controls and were significantly poorer than the other experimental groups. These latter findings were interpreted as indicating a critical period of development (4, 5) beginning at approximately the date of weaning (20 days). However, an adequate test of the critical period hypothesis requires the repetition of the experiment with all conditions the same except that older *S*s are used. This is to insure that the original findings are not merely a function of certain unique temporal relationships. The present study reports the results of such an experiment when testing is started at 116 days with extinction and reconditioning taking place at 150

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days. In addition, the initial conditioning data were used to fill in gaps of the age-conditioning function from the prior study.

B. METHOD

1. *Apparatus*

AC current passed through a standard transformer, a variable transformer, and a resistor of 2.25 megohms wired in series with *S*. The current was set at .5 ma. The grid cage was made of Plexiglas with inside dimensions of 3½″ × 7¾″ × 10″ high. A switch was connected to the shock circuit and a house buzzer. Closing one pole of the switch activated the buzzer while switching to the other pole stopped the buzzer and started the current flow through the grid. The grid was kept clean with sandpaper.

2. *Procedure*

The same procedure was followed as before (1). The day prior to testing each *S* was habituated for 5 min. in a cage similar to the test apparatus. On the test day each *S* was habituated again for 10 min. before being put into the test apparatus. When placed into the test cage, *S* was given three presentations of the buzzer alone to establish the neutrality of the CS. If *S* reacted to the buzzer, additional stimulation with the buzzer was given until no reactions were made on three successive trials. The sequence followed was: 3 sec. buzz, 12 sec. quiet; 3 sec. buzz, 12 sec. quiet; etc.

The conditioning trials were started immediately after this. The buzzer was sounded for 3 sec. followed by shock for 1 sec. Forty-one sec. elapsed between the cessation of the shock and the presentation of the buzzer for the next trial. If *S* had not quieted down by the end of this interval, the next trial was delayed until *S* had ceased moving about the cage and had been quiet for 5 sec. The conditioned response was defined as any gross movement during the interval after the buzzer had sounded and before the onset of shock. The most frequently observed CR was jumping. For any one trial an *S* could only receive a score of either 0 for no CR or 1 for a CR. Ten trials were given each *S* on any one day of testing. A CR score of 9 was the maximum possible.

Ten highly inbred C57BL/10 mice were tested at 116 days of age. Groups of five mice each were tested at 120, 130, 140, or 150 days. All groups initially tested between 116 and 140 days were retested when they were 150 days old. The *S*s were habituated on the day of retesting and were then taken to the extinction criterion of no responses to three successive buzzes before being conditioned again.

C. RESULTS

Table 1 presents the mean number of CR's on the initial day of testing, the mean number of trials to reach the extinction criterion at 150 days, and the mean number of CR's made at 150 days for the five groups used in this experiment as well as comparative data from Denenberg's previous study (1). The 150 day data in this study are not at all similar to the 50 day data of the prior study. In that study a positively accelerated function was obtained between age of conditioning and extinction at 50 days while no systematic function is obtained with the present data. Also, the previous experiment found that *S*s conditioned between 20 and 40 days had significantly higher CR scores than control *S*s when all groups were conditioned at 50 days while the 16 day group did not differ from the controls. An analysis of variance of the 150 day conditioning data found that the groups conditioned prior to 150 days were somewhat superior in their conditioning behavior at 150 days than the controls ($p = .10$), but here the group with the poorest score is the one with the shortest time interval between test and retest, which is quite the opposite result from that obtained in the earlier paper.

TABLE 1

SUMMARY STATISTICS OF INITIAL CONDITIONING, AND EXTINCTION AND RECONDITIONING DATA AT 150 DAYS AS WELL AS COMPARATIVE DATA FROM THE PREVIOUS STUDY

Age	N	Initial CR Mean	150 Day extinction Mean	150 Day reconditioning Mean
100*	10	5.90	not tested	not tested
116	10	3.40	3.00	4.40
120	5	3.00	2.00	4.60
125*	10	4.30	not tested	not tested
130	5	4.00	6.20	4.20
140	5	2.60	0.80	2.80
150*	10	2.50	0	not tested
150	5	1.80	0	not tested

* These data taken from previous paper (1).

Figure 1 presents the age-conditioning function between 13 and 150 days of age based upon combining the present results with those of the prior paper (1).

D. DISCUSSION

The effects of the buzzer-shock conditioning between 16 and 40 days resulted in statistically significant differences at 50 days which were systematic and meaningful while equivalent stimulation between 116 and 140 days did not yield such a pattern at 150 days for either the extinction or con-

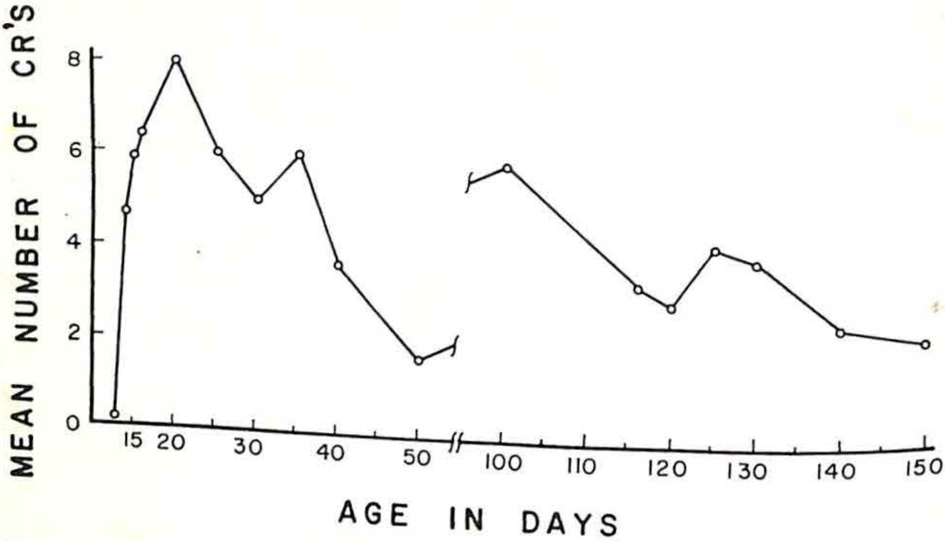

FIGURE 1

The relationship between age and conditioning between 13 and 150 days combining the results of the present study with those of Denenberg's previous study (1). N = 10 per age groups except for the following: Day 14, N = 20; Days 115, 120, 130, 140, N = 5; Day 150, N = 15.

ditioning data. In addition to the lack of a similar pattern of behavior, there are differences in absolute value as well. The *S*s conditioned between 20 and 40 days averaged approximately seven CRs at 50 days while the *S*s in this study averaged about four CRs.

Since all conditions in this and the prior experiment (1) were the same[3] except for the age of the organism, the failure to find patterns of behavior or absolute values at 150 days similar to those which had been obtained at 50 days supports Scott and Marston's critical period hypothesis (4). The hypothesis states in part that stimulation administered during certain early developmental periods will have a more marked and longer lasting effect than will the same stimulation presented at other periods in the life of the organism. The present data are quite consistent with this hypothesis.

The multimodality of the age-conditioning function presented in Figure 1 makes it appear doubtful that the empirical data are representative of age changes in only a single developmental process which can be related to learning. Instead, it is more reasonable to assume that a number of physiological and psychological processes which change with age are interacting with the conditioning procedure to bring about the present function. It has previously been suggested that the sharp rise in conditioning between 13 and 20 days is due to the rapid increase in myelinization of the brain of the mouse and to the histological maturation of the ear (1). However, these two parameters, though necessary, are not sufficient to account for the obtained data. That the sensory capacity of the mouse also is an important parameter has been shown by Yerkes (6). He tested dancing mice at 1, 4, 7, or 10 months of age in a black-white discrimination problem and concluded that the younger *S*s were the faster learners. However, when he repeated the study but increased the brightness differential so that the task was now "easier," he found that the older *S*s were the faster learners. The learning task employed is still another critical parameter. Recently Denenberg (2) has determined that the C57BL/10 mouse tested between 45-54 days of age can readily learn an avoidance learning task, though mice of the same age do quite poorly in the buzzer-shock conditioning task.

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[3] The comparability of the two experiments can be directly assessed by comparing the two sets of data for the 150 day *S*s in Table 1, one of which is from the present study while the other set is from the previous study.

Some of the other processes which change with age and could interact with learning include susceptibility to shock, differences in emotionality, changes in activity level, and differences in fearfulness. The present study on the mouse as well as the recent work of Denenberg and Kline (3) on the rat point to complex interactions between age and learning which are still very imperfectly understood and in need of extensive experimental investigation.

E. Summary

A test of Scott and Marston's critical period hypothesis (4) was made by repeating part of a prior experiment (1) with all conditions the same except that the *S*s in this study were tested between 116-150 days of age while the *S*s in the previous study were tested between 16-50 days. The response pattern and absolute values in the present study were quite dissimilar to what had been found previously. It was concluded that the data supported the critical period hypothesis.

Part of the data was also used to fill in gaps in an age-conditioning function previously described (1). Some of the parameters affecting this function were discussed.

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COMPLEXITY OF TASK AND OTHER SITUATIONAL VARIABLES AS FACTORS IN RIGIDITY BEHAVIOR OF FIFTEEN-YEAR-OLDS*

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A. INTRODUCTION

That one's mental "set" can be a facilitating or inhibiting factor in problem solving has been clearly demonstrated by Luchins in his extensive experiments on "Einstellung effects" (18, 19, 21, 22, 24, 25, 26). The boom of rigidity studies following the appearance of Luchins' monograph (18) has focused attention on the role of certain environmental and personality factors in the production of "set" or "Einstellung" phenomena. Some extrinsic factors, however, have received infrequent attention. The present study was centered on a little explored combination of situational variables in the production of rigidity behavior: complexity of task, type of task, and kind of previous learning experience. The main question posed was: does habituation in a method of concept formation produce similar rigidity behavior in simple and complex tasks and in different types of tasks?

The following hypotheses were established to be tested: (1) more rigidity behavior will be shown in a context of complex tasks than in simple tasks; (2) Einstellung effects will vary with the type of task as well as with the complexity; (3) those subjects who have been previously habituated to one single method of solution are more likely to show Einstellung effects than those not so habituated.

The few studies that have concerned the effect of complexity of task per se in the production of Einstellung effects have tended to support the first hypothesis. Maltzman and Morrisett (28) found more set effects following habituation to compound anagrams than to single anagrams. Luchins (24) reported that habituation to simple problems produced a less blinding effect than habituation to complex problems. His plausible interpretation was that

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complex problems required more organization and more selecting from among variables than simple problems (23). To shift from one complex method to a new complex method required more reorganization than to shift from a simple method to another simple method.

Evidence favoring the second hypothesis of this study can be found throughout the literature. Luchins, for example, in his "variational approach," discovered that set effects were more easily maximized with some types of tasks than with others and that a variety of materials, such as color series, mazes, anagrams, and sorting tests, could be used to produce rigidity behavior (18, 20, 24). Rokeach's failure to get the usual Einstellung results with a map test (31) suggests the importance of type of material used. The lack of correlation often found between the performances of the same subjects on different Einstellung type tasks, such as that reported by Guilford and Lacey (10), speaks for type of task differences. The ease with which the original concept is attained, the similarity or remoteness of alternative methods, the amount and kind of information presented in the problem, could be contributing factors to different set effects found from one type of task to another.

The third hypothesis is upheld in the literature. Massed practice, or increased repetition of set problems under certain conditions, has been shown to increase Einstellung effects (14, 27), although not in direct proportion to the amount of repetition (18, 22, 35). However, repeated use of a particular method when interspersed with problems requiring different types of solutions reduces Einstellung effects (18, 33). To explain the role of prior practice in the production of rigidity behavior various learning theories have been employed, from reinforcement theories, exemplified in Maltzman and Morrisett's research (27, 28), to more cognitive theories, such as Luchins' (24) and Schroder and Rotter's (33).

B. METHOD

1. *Subjects*

One hundred and sixty tenth-graders from six Minneapolis public high schools constituted the sample. They were assigned at random to make eight groups of 20 (10 boys, 10 girls) each. The sample was restricted so that all were American-born, white, and not seriously handicapped emotionally or physically. In addition, the pupils were chosen to represent roughly the middle socio-economic classes of Minneapolis and to be of the same age and IQ. They ranged in age from 15 years 3 months to 16 years 4 months, with a mean of 15 years 9 months. As tested within about three years of the time of the experiment on the Otis Quick-Scoring Mental Ability Test, Form Beta or Gamma, their IQ's ranged from 95 to 110, with a mean of 102.9 and *SD* of 4.2. A Chi-square test of homogeneity applied to the distribution IQ's for the eight groups was not significant at the 5 per cent level. Similarly, that for age was not significant.

2. *Terminology*

Following Luchins' orientation,[1] a distinction between two supposedly related aspects of rigidity behavior was made: what will be called *rigidity* or *rigidity proper* and *persistence of set.* In this study *rigidity* is conceived of as inability to solve problems by virtue of the fact that a change in method from one previously suitable is required. *Persistence of set,* on the other hand, is considered the tendency to continue using a particular method of problem solving when another good method is available. The terms *rigidity behavior* and *Einstellung effects* are used interchangeably as general terms to refer to both *rigidity proper* and/or *persistence of set.*

3. *Design of Experiment*

The experimental design involved comparisons of the eight groups of subjects on a battery of tests. Table 1 shows the test item sequence as well as the complexity of task for each group. Not shown is the fact that every subject took four such ten-item sequences, representing four different types of tasks and totalling 40 problems. The 10 problems constituting a task series were similar to each other in appearance, though not exact repetitions, so that a required or possible shift in method was not readily apparent to the subject. Each set of problems was made up of a training series of five items followed by a test series of five items.

As shown in Table 1, the effect of complexity was explored by having Groups *A, B, C,* and *D* take simple tasks while the remaining four groups took complex tasks. The habituation-nonhabituation effect was controlled by having Groups *A, B, E,* and *F* take as the training series five Einstellung problems (E, E, E, E, E) requiring the same method of solution, while *C, D, G,* and *H* took problems which required constant shifts in method (Y, C, Y, E, Z). The latter training series, requiring alternating methods of solution, has been called a "Noneinstellung" series.

To provide measures of the two different aspects of rigidity behavior, rigidity proper and persistence of set, an *Extinction* series was used as the test series for Groups *B, D, F,* and *H* and a *Critical* series for *A, C, E,* and *G.*

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[1] Note: Luchins did not deal at all with "rigidity" in his monograph (18).

TABLE 1
DESIGN OF EXPERIMENT

Group	Complexity	Solutions, Items 1 through 10									
		1	2	3	4	5	6	7	8	9	10
A	simple	E	E	E	E	E	E-C	E-C	E-C	E-C	E-C
B	simple	E	E	E	E	E	T	T	T	T	T
C	simple	Y	C	Y	E	Z	E-C	E-C	E-C	E-C	E-C
D	simple	Y	C	Y	E	Z	T	T	T	T	T
E	complex	E	E	E	E	E	E-C	E-C	E-C	E-C	E-C
F	complex	E	E	E	E	E	T	T	T	T	T
G	complex	Y	C	Y	E	Z	E-C	E-C	E-C	E-C	E-C
H	complex	Y	C	Y	E	Z	T	T	T	T	T

E—Einstellung method.
C—Critical method.
T—Extinction method.
Y, Z—other methods different from E, C, and T.
E-C—either E or C method.

The *Extinction* series required a single method of solution (T) different from any of the first five problems. By contrast, in each problem of the *Critical* series two methods of solution were possible: the Einstellung or set method (E) and another method, the Critical (C).

4. *Tests*

Since there were no available tests that would fulfill all the desired requirements for the study, new tests were developed. Ideas for them were borrowed from a number of sources (7, 8, 11, 12, 13, 30, 33, 34). A rough estimate of the difficulty level and feasibility of the tests was obtained by trying out the materials on fifth-graders, eigth-graders, and graduate students. Much revision of items ensued during these try-outs. The total 160 tasks were then administered to seven adult judges for their opinions as to the correct answers. In the final revised form of the tests there was 100 per cent agreement as to the correct answers on all but 6 of the 160 items, and on these 6 there was 6/7 agreement.

The four main types of tasks used were concept formation tests: verbal sorting tests, nonverbal sorting tests, verbal exceptions tests, and nonverbal exceptions tests. There were corresponding simple and complex forms for each of the four kinds. The simple test of each type had in its stimuli fewer aspects to be considered than the complex test, as well as fewer parts of experimental material. However, simple tasks later proved to be not necessarily easier than complex tasks.

A description, with some illustrations, of all the 160 problems may be found elsewhere (2), so that a complete presentation will not be attempted here. A summary of the main features of the tests, along with some examples, is given below.

a. Verbal Exceptions Simple (VES). The subject's task in VES was to find the word among six that was different from all the rest for some reason. Each item consisted of six words typed in a vertical column on a 6″ by 3½″ page of a loose-leaf notebook. It was impossible to see more than one page of words at a time. Principles of solution with illustrative items follow. The abbreviations are explained in Table 1.

E — word beginning with letter different from the rest (ruler, ribbon, rope, saucer, rice, radish).

C — word belonging in different content category from the rest (car, bus, train, truck, rock, boat).

E-C — either E or C method (bamboo, oak, bed, barley, birch, bean).

Y — word that is a verb (went, pond, hut, path, star, sun).

Z — word with more than three letters (eat, say, ask, sit, lay, straighten).

T — word that does not rhyme with the rest (coat, boat, note, lace, vote, moat).

b. Verbal Exceptions Complex (VEC). The subject's task was to find among nine rows of words the row that was different from the rest. The material was identical in construction to that of VES except that nine pairs of words were arranged vertically on the page instead of six single words. Principles of solution are given below.

E — row in which adjective belongs to different content category from rest of adjectives (singing sparrows, chirping wren, cawing crows, hooting owl, flying hawk, screaming eagle, talking parrots, calling thrush, chatting catbird).

C — row in which noun belongs to different content from remaining nouns (foolish uncle, lazy sister, careless maid, older brother, fond father, helpful aunt, younger niece, cross mother, nice nephew).

E-C — either E or C method (oak chair, soft couch, iron beds, brass crib, pine tables, maple sofa, steel desks, copper penny, walnut chest).

Y — row in which adjective has different suffix from others (useful wagons, fruitful crop, beautiful sunset, playful kittens, cheerful song, grateful puppy, pleasant word, colorful gardens, peaceful nation).

Z — row in which the noun is the general term (white lily, fragrant violet, yellow daisy, small buttercup, sweet rose, pretty flower, large dandelion, pink tulip, beautiful pansy).

T — row in which there is no alliteration from adjective to noun (courageous crew, tall tree, rude robber, silent sheriff, green goggles, best beds, dark door, cold climate, open window).

c. Perceptual Exceptions Simple (PES). Here the subject had to find the figure that was different from all the other five for some reason. The figures used, though not all in a single problem, were a wide cross, diamond, square, eight-pointed star, and equilateral triangle, heptagon, hexagon, and octagon. They were colored green, blue, red, or yellow and usually had an inner line parallel to the border. The inner line was continuous or dashed. The figures, of about equal size, were drawn on 2″ by 2″ cards which were mounted in two horizontal rows of three each on 8½″ by 11″ notebook paper. Principles of solution follow.[2]

E — only figure with double solid line around it.

C — figure different in shape from all the rest.

Y — figure oriented on the card differently from the rest.

Z — figure with no inner line.

T — figure of different color from all the rest.

d. Perceptual Exceptions Complex (PEC). From a page on which were mounted nine cards the subject was required to choose the one that was different from all the rest for some reason. On each card was drawn a row of small colored discs equal in size and touching one another. There were four possible orientations of the row on the card (horizontal, vertical, two diagonals), the number of discs varied from two to four, and each disc was colored blue, green, yellow, or red. In addition, almost all discs had a one-digit or two-digit number written in them. The overall construction paralleled PES, there being three rows of three cards each instead of two rows of three. Principles of solution are given below.

E — card in which the number sequence, reading from left to right, was according to a different principle from all the rest.

C — card in which the rows of discs were oriented differently from all the rest.

Y — card on which there were no numbers.

Z — card in which all discs were the same color.

T — card with different number of discs from all the others.

e. Verbal Grouping Simple (VGS). The problem was to sort six cards, each of which had a word typed on it, into two groups of three cards each. The six cards each measured 2″ by 4″. In the administration, as in all grouping tests, a screen was placed between the subject and cards until the latter were set on the table, face up, in a standard order. Below are given the bases of grouping.

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[2] Since examples are not given with the descriptions of nonverbal items, "E-C" is omitted in the listing.

E — word ending in the same letters (green, top, oven, scallop, shop, ten).

C — words with similar meaning (weak, feeble, clever, fragile, skillful, talented).

E-C — either E or C method (angry, grumpy, delayed, tardy, annoyed, postponed).

Y — words beginning with the same two letters (candy, cherry, chin, cap, camp, chair).

Z — specific places vs. general places (state, country, Holland, city, Paris, Utah).

T — words beginning and ending with the same letter vs. words with two consecutively same letters (narrow, traffic, tenant, stars, pussy, area).

f. Verbal Grouping Complex (VGC). The task was to sort cards bearing one or more words into three groups of three cards each. The format was the same as in VGS. In the examples given below, words in italics were underlined in the actual test items. The parentheses, not appearing in the original test material, demarcate the contents of each card.

E — number of words (The fleet wasted no time.) (Which squirrel buried the nuts?) (Echo) (Does it float?) (Peru) (Mary stood still.) (Postcards are cheaper than letters.) (Carving) (Fresh tar sticking).

C — belonging together by content (Silk thread breaking) (Who will mend the rip?) (Acres of wheat covered that region.) (Gathering wood for the fire) (Thimble) (Does the furnace need coal?) (They need oil for that burner.) (She disliked weeds in her lawn.) (Growing grass).

E-C — either E or C method (Who mixes cement?) (Heavy snow bent the shovel.) (A sharp rake) (The plaster wall fell in.) (Piano) (He was hoeing.) (Did you hear the violin?) (Saxophone) (Bricks).

Y — beginning with the same word (This pillow is too hard.) (Many voices) (Can he spell it?) (Many pictures to take) (Many rugs were made in Persia.) (Can birds swim?) (This man looks innocent.) (This tree is very old.) (Can you see through this?).

Z — form: all capital letters vs. small and capital vs. underlined (HIS REPLY WAS ACCEPTED.) (What scraped the table?) (They survived.) (*He sold ten brushes.*) (BROKEN WAGON) (*How did you succeed?*) (Crying loudly) (*The flowers were in bloom.*) (GOOD FORTUNE).

T — grammatical structure: phrases vs. declarative sentences vs. questions (Did the lights change?) (Radio out of order) (The toad jumped.) (Mink coats cost money.) (Which dog disappeared with the meat?) (Busy bees) (Leaking roof) (Who first tried it?) (The footman opened the door.).

g. Perceptual Grouping Simple (PGS). The problem was to sort six cards, on each of which was a horizontal row of three figures, into two groups of three cards each. On every card the first and last figure in the row were identical. The figures were either elongated vertically or were small and equilateral. The elongated figures included a diamond, rectangle, triangle, hexagon, octagon and a spool-shaped figure. Shapes used for the small figures were a circle, square, diamond, triangle, heptagon, and hexagon. Border lines usually appeared at the top and always at the bottom of each card. The cards measured 2½″ by 3″. The principles of grouping appear below.

E — identical figures on each card vs. mixed figures.
C — all small figures vs. all large figures.
Y — similarity of outer figures.
Z — similarity of inner figures.
T — number of border lines on card.

h. Perceptual Grouping Complex (PGC). In this test there were nine cards to sort into three groups of three. On each card were drawn two figures, one inside the other, and a conspicuous dot. The outer figures varied in number of sides, size, and, in the case of the largest ones, in proportion (equilateral, elongated, much elongated). The inner figures were all equilateral and varied in size and number of sides only. The dot, invariant in size except for one problem, appeared innermost, between the two figures, or outside both. The figures were all symmetrical, but differed in their orientation on the page. Considering the various sizes and proportions, there were in all 61 discretely different forms used in making the experimental material: 13 circles, 9 triangles, 9 rectangles, 3 rhomboids, 5 rhombuses, 8 heptagons, 10 hexagons, and 4 octagons. Circles were never used as outer figures; octagons and rhomboids never appeared as inner figures. The cards were the same size as in PGS. The principles of grouping follow.

E — relative position of dot: innermost vs. between figures vs. outermost.
C — number of sides of outer figure.
Y — size of outer figure: small vs. medium vs. large.
Z — size of dot: small vs. medium vs. large.
T — shape of inner figure.

5. *Administration of Tests*

Each pupil was tested individually in one session during a free school period. The Dvorine Color Discrimination Screening Test, Form *B*, was administered first to eliminate the color-blind from the sample. This was followed by two short demonstrations to illustrate how things are sorted and how to find exceptions. Buttons varying in size, color, and number of holes were used for the sorting demonstration. Paper clips differing in color, texture, and size served for the exceptions demonstration. Then followed the four task series. The order in which a particular pupil took these four was predetermined by random numbers.

A record of the subject's responses and response time for each of the 40 problems was kept. Regardless of failures, all 40 problems were always presented. Before the tasks were administered, the subject was requested not to give reasons for his solutions and was informed he would not be told the correctness of his responses. Aside from giving the necessary instructions, the examiner kept in the background as much as possible and did not encourage conversation. A maximum of five minutes was allowed for each problem, but this time limit was rarely invoked.

The specific instructions preceding administration of a particular ten-item series depended upon the complexity and type of task. They are given below.

Simple exceptions tasks. "There will be six (words) (figures) on the page. Look carefully and see if you can find the (word) (figure) that is different from all the rest for some reason." (Notebook opened to proper place handed to subject.)

Simple grouping tasks. "Now we've got some cards to sort. I'll give you six cards and you try to sort them into two different groups with three cards in each group the way you think they should go. Tell me when you're done." (Screen put up while cards arranged, with brief explanation of its purpose the first time used.)

Complex exceptions tasks. "There will be nine (little cards) (rows of words) on the page. Look carefully and see if you can find the (card) (row) that is different from all the rest for some reason." (Notebook opened to proper place handed to subject.)

Complex grouping tasks. "Now we've got some cards to sort. I'll give you nine cards and you try to sort them into three different groups with three cards in each group the way you think they should go. Tell me when you're done." (Screen put up, with explanation.)

C. RESULTS

1. *Survey of Methods*

The primary method used in the treatment of the data was a three-way analysis of variance technique to test the significance of difference among group mean values for the following criteria:

a. As indicative of rigidity proper: the number of problems solved correctly in the Extinction series (the fewer correct, the more rigidity).

b. As indicative of persistence of set: (1) the number of Einstellung responses given in the Critical series; (2) as a secondary criterion, the number of Critical responses given in the Critical series (the fewer the Critical responses, the more persistence of set).

In a second method Chi-square was employed to see whether certain patterns of response had any association with complexity of task, type of task, and previous training. The scope of this paper does not permit more than a brief summary of the findings from this second method.

2. *Analysis of Variance*

Analysis of variance results for number of successes in the Extinction series and for number of Einstellung responses in the Critical series are given in Tables 2 and 4 respectively. The means and *SD*s on which the analyses were based are presented in Tables 3 and 5 under "Total Sample."[3] The values under "Restricted Sample" were not submitted to an analysis of variance. They were based only on those subjects who achieved at least three correct solutions out of the first five problems of the particular ten-problem series in question. Presumably those who did not build a set because of many failures on the training series were eliminated by this technique.

A three-way analysis of variance design allowing for confounding between subjects and type of task was chosen. A fairly stringent level of significance was used, .025, because of some slight questionability in meeting all the assumptions in the use of analysis of variance.[4]

a. Extinction series results. Table 2 shows that although the main effect "Complexity of Task" was not a significant one, the interactions "Habituation × Complexity" and "Type of Task × Complexity" were. Though there was no consistent and reliable tendency for less rigidity to be shown in simple tasks than in complex, or vice versa, the complexity of the task in conjunction with differences in prior habituation or in type of task was associated with variations in rigidity. Table 3 reveals the direction these effects took. For

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[3] Unless otherwise stated, results and values referred to are from the total sample.

[4] One assumption, that the variance of the criterion measures is the same for each group, was not met with regard to the number of successes, Extinction series, according to Bartlett's Test of Homogeneity, though it was for the two criteria of persistence of set. However, Lindquist's encouraging conclusions about the Norton study (17, p. 86) indicate that the findings for the Extinction series are not necessarily invalid, since marked heterogeneity is not present. The fairly stringent level of significance was thought advisable also because the normality of distribution of the criterion measures was questionable.

TABLE 2
ANALYSIS OF VARIANCE FOR NUMBER OF SUCCESSES, EXTINCTION SERIES

Source	df	Mean square	F	P
Between subjects	79	4.89	1.24	—
Complexity of Task	1	11.63	2.57	—
Habituation	1	.38	.08	—
Habituation × Complexity	1	30.63	6.77	.025
Error (b)	76	4.52		
Within subjects	240	3.93		
Type of Task	3	15.60	6.12	.001
Type of Task × Complexity	3	95.24	37.36	.001
Type of Task × Habituation	3	2.50	.98	—
Type of Task × Habituation × Complexity	3	7.70	3.02	.05
Error (w)	228	2.55		
Total	319			

most types of tasks it appeared that an Einstellung series preceding an Extinction series was more of a handicap in the case of complex tasks than in simple tasks. In all types of simple tasks, *B,* the Einstellung group, did better than *D,* the Noneinstellung, though sometimes the differences were slight. For example, in PGS Group *B* averaged 1.40 correct solutions and Group *D* 1.10. By contrast, in all complex tasks except PGC, Group *F,* the Einstellung, did less well than *H,* the Noneinstellung. In VGC, for instance, *H* averaged 3.90 correct, whereas *F* averaged 2.60.

In most cases the differences between corresponding Einstellung and Noneinstellung groups were accentuated in the restricted sample, as would be anticipated. An accentuation occurred, for example, for VEC. As shown in Table 3, when the total sample was used, Group *H* averaged .25 more successes than *F*. For the restricted sample the difference was 1.16 and in the same direction.

"Type of Task" was the only main effect which was significant. Table 3 shows that the mean number of successes for each group varied considerably from task to task. For example, *B* averaged 4.45 correct on VES, 1.45 on PES, 3.30 on VGS, and 1.40 on PGS. The *t* test revealed that of the six intertask comparisons made for each group, 17 proved significant at the 5 per cent level. The insignificant differences appeared between various grouping and exceptions tasks for Groups *B, D, F,* and *H* and between PGC and VGC for *F*. Because of questionable validity in the use of the *t* test here, these specific findings should be accepted with caution.

The insignificant main effect "Habituation" indicated that the number of successes in the Extinction series did not depend in a consistent way on

TABLE 3
MEAN NUMBER OF CORRECT RESPONSES, EXTINCTION SERIES, BY TYPE OF TASK AND EXPERIMENTAL GROUP

Group	Total sample[a]			Restricted sample	
	Mean	SD	N	Mean	SD
			Verbal Exceptions		
B	4.45	.92	19	4.53	.88
D	4.30	1.23	17	4.18	1.29
F	1.45	1.50	18	1.28	1.45
H	1.70	1.85	9	2.44	1.83
			Perceptual Exceptions		
B	1.45	2.06	11	2.09	2.19
D	1.35	1.82	19	1.42	1.84
F	2.80	1.43	16	3.06	1.43
H	4.05	1.07	17	3.94	1.11
			Verbal Grouping		
B	3.30	1.98	15	4.13	1.50
D	1.65	1.77	13	2.15	1.99
F	2.60	2.13	9	3.22	1.75
H	3.90	1.45	18	3.89	1.49
			Perceptual Grouping		
B	1.40	1.88	11	1.73	2.09
D	1.10	1.34	15	1.13	1.02
F	2.80	2.13	12	4.08	1.66
H	2.75	1.97	6	3.50	1.26

[a] N = 20 per group.

whether an Einstellung or Noneinstellung series preceded the Extinction series.

b. Critical series results. Table 4 shows that in regard to the number of Einstellung responses given in the Critical series, the main effect "Complexity of Task" proved again insignificant. In addition, there were no significant interactions.

As one would expect, "Type of Task," which was significant at the .025 level, had a definite association with the strength of the Einstellung effect. Certain kinds of material favored the development of set more than others. The location of the significant intertask differences was done, as in the Extinction series results, by use of the *t* test, involving 24 comparisons in all. Fourteen of these met at least the 5 per cent level of significance. They seemed to follow no particular pattern; they occurred between the two kinds of exceptions tasks for various groups, between the two grouping tasks, between grouping and exceptions tasks, and as often between complex tasks as between simple tasks. Because of the questionability in use of the *t* test here, these findings should not be given too much importance.

TABLE 4
ANALYSIS OF VARIANCE FOR NUMBER OF EINSTELLUNG RESPONSES, CRITICAL SERIES

Source	df	Mean square	F	P
Between subjects	79	7.28	1.90	.01
Complexity of Task	1	.08	.02	—
Habituation	1	216.15	46.56	.001
Habituation × Complexity	1	5.78	1.24	—
Error (b)	76	4.64		
Within subjects	240	3.82		
Type of Task	3	13.04	3.51	.025
Type of Task × Complexity	3	2.76	.74	—
Type of Task × Habituation	3	.59	.16	—
Type of Task × Habituation × Complexity	3	6.78	1.82	—
Error (w)	228	3.71		
Total	319			

The really striking effect, significant beyond the .001 level, was the "Habituation" one. There was a marked and consistent tendency for all Einstellung groups in all types of tasks, simple as well as complex, to show more set effects than corresponding Noneinstellung groups. As shown in Table 5, for all tasks Group *A* averaged more Einstellung solutions than *C*, and *E* averaged more than *G*. With one exception, all differences between Einstellung and corresponding Noneinstellung groups were accentuated when the sample was restricted. Thus, as given in Table 5, Groups *A* and *C* averaged 3.50 and 1.05 Einstellung responses respectively on VES when the total sample was used, but 4.31 and .67 respectively when the sample was restricted.

An analysis of variance was also done using the secondary and less satisfactory criterion of persistence of set, the number of Critical responses given in the Critical series. This criterion was not an exact converse of the primary one, the number of Einstellung responses, because failure to give a Critical response could be due either to employing the Einstellung method or to finding no solution at all. In the analysis of variance the appearance of significant effects agreed with those for the primary criterion with one exception: "Complexity of Task" proved significant at the .01 level for the secondary criterion. The mean square was 31.88 and *F* was 8.58. Fewer Critical responses, or presumably more set effects, were shown by *E* than by *A* in just two types of tasks, verbal exceptions and perceptual exceptions. The effects were a little more consistent when the means for *G* and *C*, the Noneinstellung groups, were compared. *G* showed more set effects than *C* in all tasks except perceptual exceptions.

TABLE 5
MEAN NUMBER OF EINSTELLUNG RESPONSES, CRITICAL SERIES, BY TYPE OF TASK AND EXPERIMENTAL GROUP

Group	Total sample[a]		Restricted sample		
	Mean	SD	N	Mean	SD
		Verbal Exceptions			
A	3.50	2.11	16	4.31	1.80
C	1.05	1.60	18	.67	1.73
E	3.05	1.46	18	3.17	1.46
G	1.80	1.17	7	2.00	1.19
		Perceptual Exceptions			
A	2.35	2.22	12	3.83	1.62
C	1.25	1.67	18	1.39	1.70
E	3.35	2.00	13	4.54	.75
G	1.05	1.88	16	1.31	2.02
		Verbal Grouping			
A	3.05	2.13	14	4.29	1.16
C	1.00	1.55	15	1.20	1.68
E	2.05	2.33	7	4.14	.97
G	1.20	1.50	16	1.12	1.32
		Perceptual Grouping			
A	3.90	2.27	15	4.93	.25
C	1.85	2.26	19	1.95	2.28
E	3.15	2.26	10	4.50	1.20
G	2.05	2.04	3	2.00	.82

[a] N = 20 per group.

3. *Chi-square*

In the Chi-square analysis the sample was restricted to those who had solved correctly at least three of the five problems in the training series of the task series in question. The sample for Groups *A, C, E,* and *G* was further restricted to those who got at least three correct on the Critical series, either an Einstellung or Critical response being considered correct. Particular patterns of response rather than a single criterion were taken as indicative of rigidity behavior, the aim being to make broad categories based on more than one facet of rigidity behavior.

The patterns for those taking the Extinction series, from "least rigid" to "most rigid" were:

I. Success on Item 6, with total of three to five correct in the Extinction series.

II. First success on Item 7 or 8, with total of three to four correct in the Extinction series.

III. One to two items correct in the Extinction series.

IV. No correct responses in the Extinction series.

The patterns for groups taking the Critical series from "least persistence of set" to "most persistence of set" were:

I. Two or more shifts, first Critical response occurring on Item 6 or 7. (A shift, counted beginning with Item 6, was a change from an Einstellung response to a Critical response or vice versa whether wrong responses intervened or not.)

II. One shift only, first Critical response occurring on Item 6 or 7.

III. One or more shifts, first Critical response occurring on Item 8, 9, or 10.

IV. Three to five Critical responses, rest of Critical series failures.

V. Three to five Einstellung responses, rest of Critical series failures.

The results from the Chi-square analysis generally substantiated the analysis of variance findings. Where the results diverged, this divergence may perhaps be ascribed to the different criteria and methods employed, as well as to restriction of the sample. A P of .05 or less was considered significant. In the Chi-square analysis, when type of task was pooled, less rigidity proper was evidenced in simple tasks which had been preceded by an habituating series than in complex tasks. That is, Group *B* showed significantly less rigidity than *F*. Complexity of task was apparently not a factor in determining strength or persistence of set, however. Type of task was associated with performance on the Extinction series, but was not a significant factor in the Critical series performance. The kind of previous training, in terms of an habituating or nonhabituating series of problems, was of minor significance in determining ability to shift to new methods on the Extinction series, but a very important variable in determining strength of set, as shown in the Critical series.

D. Discussion

1. *Criteria of Rigidity Behavior*

First of all, it appeared that "persistence of set" could not be equated with "rigidity" as defined in this study, since certain effects were strikingly significant when the former aspect of rigidity behavior was considered, but not when the latter was. This evidence is consistent with viewpoints expressed by Luchins and also by Guetzkow (9), but not with Levitt and Zelen (16).

2. *Support of Hypotheses*

The three hypotheses of this study were supported in part. The results did not clearly uphold the supposition that more rigidity behavior would be shown in a context of complex tasks than in simple tasks. In the case of rigidity proper, significant differences appeared for the interaction of complexity of task with other factors rather than as a simple function of complexity of task. In the case of persistence of set, evidence favoring the hypothesis was again equivocal. Refinement of the present experiment could perhaps produce more revealing results. Ideally, the tasks at each respective complexity level should be standardized to be of equal difficulty. In addition, the simple and complex tasks should be as similar as possible except in the dimension of complexity. Furthermore, if the simple and complex tasks were at opposite poles of a continuum of complexity instead of somewhere in the middle, more significant results might be obtained.

The hypothesis that rigidity behavior would vary with the type of task was upheld. From the significant differences found, one can confidently conclude that, irrespective of other variables, certain kinds of tasks facilitate set effects more than others.

The last hypothesis, that those previously habituated to one single method of solution would be more likely to show Einstellung effects than those not so habituated, was unequivocally supported only with regard to the persistence of set criteria. The habituating or nonhabituating character of a series of problems seemed to be more important than either the type or complexity of task in determining persistence of set. For rigidity proper there was a trend favoring the hypothesis for complex tasks only.

3. *Extrinsic and Intrinsic Factors in Rigidity Behavior*

Through the present experiment highlighted the importance of certain extrinsic factors in the production of rigidity behavior, informal observation suggested that intrinsic factors were also at work. Individuals had their own personal inclinations and expectancies which they brought with them to the testing situation. In addition, some subjects appeared to find the situation more stressful than others.

For Groups *G* and *H* as a whole it appeared that frustration tolerance was put to test in at least one instance. Through a bad choice of items, Problems 1 and 3 of the Noneinstellung series of PGC were failed by the majority of subjects. Possibly *H*'s poor performance on the Extinction series of PGC could be traced in part to these "interpolated frustration" problems. PGC was the only task in which *H*, the Noneinstellung group, did more poorly on the Extinction series than *F*, the corresponding Einstellung group. Interpolated frustration problems, stressful situations, and anxiety have been reported to increase rigidity (1, 3, 4, 5, 6, 18, 29, 32) though some of the evidence has been shown to be equivocal (15). A tendency to behave in stereotyped ways when situations become cognitively more difficult has been demonstrated in animals as well as in human beings.

4. *Conclusion*

It is evident from the results that rigidity behavior, as conceived of in this paper and as found in a sample of normal fifteen-year-olds, is a function of an interaction of factors. Some of these are undoubtedly internal to the organism, while others, as demonstrated in this paper, are external. As Luchins has said, regarding his Einstellung experiments, "It may be concluded that problem solving behavior is influenced by the nature of the problem, the nature of the problem solver, past experiences of various kinds, and present field conditions" (24).

E. SUMMARY

One hundred and sixty fifteen-year-olds took batteries of concept formation tests designed to measure Einstellung effects as a function of certain situational variables. The tests used were verbal sorting tests, nonverbal sorting tests, verbal exceptions tests, and nonverbal exceptions tests. Two main criteria of rigidity behavior were used: (1) the inability to shift to a new method when a previous method no longer worked; (2) the tendency to persist in the use of a method when another good method was available. It was hypothesized that Einstellung effects would vary with the complexity of task, the type of task, and also with the habituating or nonhabituating character of prior problems taken.

The hypotheses were supported in part. Evidence from this study that rigidity behavior varies as a function of complexity of task was equivocal. The assumption that Einstellung effects vary with type of task was supported, and especially so in regard to the first criterion. The expectation of more Einstellung effects in those previously habituated to a certain method than in those not so habituated was confirmed strikingly when the second criterion was used, but not clearly with the first. In agreement with Luchins and others, it appeared that susceptivity to set could not be equated with ability to surmount set. It was concluded, in line with Luchins, that, while individual differences are not to be denied, situational factors are important variables in rigidity behavior.

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